The Foundry Trade Journal

AND PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION

Vol. 13. **APRIL, 1911.** **No. 112.**

PUBLISHED THE FIRST WEEK IN EACH MONTH.

Subscription Terms: 7s. 6d. per annum, post free.

To place the "JOURNAL" within the reach of Working Moulders and Pattern-makers the Proprietors will accept subscriptions, not less than three in number from one shop at the reduced rate of **5s.** per annum, such order to be countersigned by the superintendent or foreman.

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THE FOUNDRY TRADE JOURNAL,
165, Strand, London, W.C.

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Forthcoming Events.

APRIL 7.

British Foundrymen's Association (London Branch.—"Brass and Bronze Alloys," by Percy Longmuir, B.Met. Meeting at Cannon Street Hotel.

APRIL 8.

British Foundrymen's Association (Scottish Branch).—Monthly meeting and discussion.

APRIL 22.

British Foundrymen's Association (Birmingham Branch).—"Some Impressions of Continental Foundry Practice," by J. Shaw.

British Foundrymen's Association (Sheffield Branch).—Paper by S. G. Smith (Chesterfield).

NOTES AND COMMENTS.

Accidents and their Prevention.

With the rapid growth in the number of mechanical appliances now used in all manufacturing processes, the question of industrial accidents and their prevention assumes increasing importance year by year; for the tendency is not towards a decrease in accidents, but rather the reverse. In the foundry, too, although that department is often behind others as regards mechanical equipment, the pressure of competition and the consequent speeding up of operations has had a similar effect. But that much can be done to eliminate the risks that too often exist cannot be denied, and the matter is receiving careful attention at the hands of our more progressive men. A few weeks ago the Report was issued of the Departmental Committee appointed to inquire into the causes and circumstances of the increase in the number of reported accidents in certain classes of factories and workshops, and other premises under the Factory Acts. The Report opens with a preliminary statistical survey, showing that the number of accidents has increased. As to the causes tending to increase or decrease accident risk, the opinion is expressed that the accident risk for the ten years from 1897 to 1907 probably remained almost constant, any increase due to increase of machinery and greater pressure being counteracted by improved inspection, and the greater care resulting from the Workmen's Compensation Act. Since 1907 there has been a tendency for the accident risk to decrease, and there can be no doubt that this result is due partly to the greater care resulting from the Workmen's Compensation Act, partly to the greater experience of employers in the efficient guarding of machinery, and partly to the efforts of the Factory Inspectors. It is also probable that any increase took place chiefly in the class of unpreventable accidents, while improvement has been effected as regards preventable accidents. Though the border line between preventable and unpreventable accidents is a doubtful and moving one, there must always be a number of accidents which no care can foresee or prevent; and it seems possible that the increase of machinery and the increased speed and pressure of work have enlarged this class of accidents. The increase of reported accidents up to 1907 was due almost entirely to increased reporting. Since that date the increase in reporting has been less marked, and the effect of decreased risk has accordingly shown itself in the figures of reported accidents.

So far the Report appears very encouraging, indicating a tendency towards greater care and consideration for the prevention of accidents. But that there is still much to be done is indicated by the fact that in regard to the prevention of accidents the Committee have come to the conclusion that all possible steps must be taken to secure (1) that the employers shall co-operate with the inspectors; (2) that a knowledge of the risks of new machines and the best ways of fencing them shall be diffused widely and quickly; and (3) that the best methods of fencing shall be enforced with speed and uniformity. The Committee submit a number of proposals

with a view to effecting these objects. It is suggested that there should be conferences between representatives of employers, workpeople and inspectors at reasonable intervals for the purpose of discussing the dangers that arise in a particular trade or a particular district and the best means of preventing them; that specialised reports on industrial dangers should be made by inspectors; that there should be conferences between inspectors to ensure uniformity of requirements; and that as far as possible the machines and parts of machines which require guarding should be specified.

Causes of Accidents.

There are many causes of accidents, or circumstances conducing to risks, that come under the jurisdiction of the inspectors, but outside these there are also many which are at present left to the proprietor of a plant, and which must, of necessity, be matters for his personal attention and judgment, rather than for Government Regulations. In the course of the evidence it appeared that in a considerable number of places there was inadequate lighting both in passages and in work places. The Secretary of one large Union said the lighting in iron and steel works was sometimes very bad, and one of the inspectors said he had noticed such cases occasionally. Another witness, however, said an improvement was being effected in these places by the introduction of electricity. As regards iron foundries, inadequate lighting was one of the chief complaints of the Society of Ironfounders. In the absence of a standard, definite regulations, such as exist in certain foreign countries, would lead to considerable difficulties in administration, but even before a standard can be arrived at, the Committee recommend that the inspectors should be given general statutory powers to require adequate lighting in all places where work is done, and in all places which are a source of danger by reason of insufficient lighting. A representative of the Friendly Society of Ironfounders brought before the Committee the following points. (1) Foundries are often badly lighted; (2) they are often very dirty and more frequent lime-washing might improve the light as well as add to the comfort of the workers; (3) the habit of laying plates on the foundry floor between the lines of rails is dangerous, because hot metal falling on the plates splashes and causes burns, and because the splashes form into balls, and on the iron plates such balls roll under the feet of the workers and cause falls; (4) if the iron is allowed to run quickly out of the furnace and in large quantities, the practice of catching it in ladles is dangerous; the witness thought in no cases should it be caught in ladles carried by hand; (5) iron plates should not be placed under the furnace spout, as they increase the danger of splashes and burns; (6) foundries are often cumbered with the boxes used for sand casting; men have to carry ladles of molten metal between these boxes and often insufficient space is left; falls and burns are increased by this overcrowding; (7) boys under eighteen should not be allowed to carry vessels containing molten metal; to do so requires both strength and skill, and burns often result from the employment of young and inexperienced persons in this work. The Committee suggest that these are matters which might be investigated by the inspectors and discussed at conferences with employers and employed. It appears possible that statutory regulations for iron foundries may be found necessary after such inquiry and discussion, and while there will be many who will protest against any further regulations and "restrictions" in the conduct of their works, it will probably be found that where due consideration has been given to the proper conduct of the work and the safety of the men, such regulations are already being complied with.

Forthcoming Convention of British Foundrymen.

At last month's meeting of the Glasgow Branch of the British Foundrymen's Association, the Branch President announced that arrangements were now fairly well advanced for the forthcoming Convention of the Association to be held at Glasgow during Bank Holiday week. The Corporation of Glasgow had been approached by the local Council to give the members of the Foundrymen's Association a civic reception on the occasion of their visit, and while as yet nothing definite had been settled, they were hopeful that the Corporation of Glasgow would most cordially acquiesce in the request. Towards the end of the week the probability was that an excursion, on distinctly popular lines would be arranged, but meanwhile the local Council was desirous that members of the Glasgow Branch should endeavour to contribute a few interesting papers likely to stimulate and give rise to profitable discussion.

A member asked if some arrangement could not be entered into whereby the papers could be re-read and discussed in the evenings. He pointed out that, although it was Bank Holiday Week in England, it was not a holiday season in Scotland, and all the foundries, etc., were in full swing, so that many members of the Association had really not an opportunity of attending the meetings during the day.

Mr. John Ewen (Branch Secretary) said he had been in communication with the General Secretary, who urged the point that all papers intended to be read at the Annual Convention of the Association on the 8th, 9th and 10th August, should be in his hands by April 30th. The idea of that was to ensure that the papers would not only be printed, but that advance copies of these would be in the hands of each member about a month or six weeks before the Convention took place. With reference to the proposal that some of the papers might be read and discussed at evening meetings, he might mention that that very point had been under the consideration of the local Council. They were still dealing with the subject and members could rest assured that the best course possible, under the circumstances, would be pursued.

A Coke Question.

Whenever the matter of coke comes up for discussion before foundrymen, a variety of conflicting opinions may be heard, touching the various features of the fuel, and the most suitable tests as to its quality. Take, for example, the question of whether or not a good foundry coke should sink in water. On this point cupola men are sharply divided, except perhaps for the few who agree that a coke of either class—the sinking or the floating—may be a suitable fuel for their use, according to its other qualities; and even the foremost men in the foundry ranks still pit their opinions one against the other. Many prefer a dense coke for cupola work, but others claim that they are paying unduly for their preference, since a lighter coke will give the requisite stability, and prove more economical in melting. The retort to this assertion is that the excessive formation of carbon monoxide which occurs when a light and porous coke is used, results in a loss of heat and consequent waste. As regards the relative values of beehive coke and by-product oven coke, a common opinion is more likely to be arrived at, since the economical aspect is a more obvious one. Undoubtedly the bee-hive oven is doomed to extinction, for it must be ranked among the old, wasteful and expensive processes, as compared with its more modern rival. Present day conditions

demand that by-products from all manufacturing processes be recovered and utilised where possible, and since it has been conclusively proved that the old preference for beehive coke was not based on its actual superiority, but rather on the fancy of the foundryman for its appearance, it has little claim to demand the higher price. Reverting, however, to the question of density and pore-space, it is unlikely that any agreement will be arrived at until very exhaustive and systematic experiments are carried out with a view to determining the points at issue. There is, undoubtedly, a fairly wide range within which cokes may vary and still be made to give good melting results; but there is also a definite, although as yet undetermined, density and pore structure which gives the best results under specific conditions, and it is probably the fact that conditions and methods of operating furnaces vary somewhat that prevents the ready arrival at a definite conclusion on the matter. So until some beneficent body undertakes the necessary experimental work, we must gather what help we can from the conflicting opinions available, or experiment each for himself under the conditions existing in his own foundry—a course which many appear to be adopting with some profit.

The Neglected Pattern-Shop.

V. Dewhurst.

Until the last few years the pattern shops of large general engineering works have been somewhat neglected. Unless the firms are new ones, or the old firms have had the misfortune of a "fire" in the pattern department, the pattern shop often is some old building, containing older machinery, and situated in some corner not conveniently near to the foundry.

According to the writer's experience, in some cases, even with firms of a world-wide reputation, the circular saw, for instance, is the very oldest piece of machinery the works contains. Its travels and troubles are quite historic, and its close acquaintanceship with the growth and fortunes of the firm seems to have ensured it (apart from all its remaining good and bad points) a charmed life against the fate of the scrap heap and melting pot, its only fit and proper place. At other places the lathes have been apparatus which would impart a circular together with a more or less (often more) reciprocating motion, but with a reputation such that a pattern-maker would often find himself in doubt as to whether he could not cut the particular piece of work by hand quicker than by the lathe with the elaborate preparation necessary to get it to turn true.

The band-saw (if in good condition the most useful machine in the shop), is often found to be in anybody's care. So long as it will cut at all, it is deemed to do all that is required of it. Trimming-knives on their first appearance in the pattern shop were a source of considerable assistance to the pattern-maker, and they were also a small means of profit to the firms installing them; but familiarity has bred contempt, and so long as they will "yark" a sixteenth off the grain-end they are considered to pass muster.

The writer witnessed one case of a firm who have been constructing large and small locomotives for a number of years, but who treated the pattern shop with such indifference that no assistance towards improvement could be obtained from the heads. Although the foreman time and time again requisitioned a planing machine, and took every opportunity to explain its saving in cost, and also its utility and profit, he was always put off. Not until his retirement after 42 years' service did they acquire one, when a new foreman simply laughed at the shop being without such a machine, but even then it was a second-hand one, whose days of accurate work were over.

The pattern shop, no doubt, is and has been an expensive item to the general engineering and jobbing works. The method of distributing its cost over the whole of the work produced in other shops, and including it also partly as management expenses, may account in some measure for its indifferent consideration and attention, and yet there are very few pattern shops, if given a fair chance, whose expenses could not be reduced from 30 per cent. to 50 per cent.

The pattern stores is another inner department that often escapes the notice of the heads. The method, if it can be called method, of keeping and storing patterns is usually very loose, and without system, and often dependent upon the memory only of a man termed the pattern seeker; and this word "seeker" aptly describes the general condition of many pattern stores, even in so-called up-to-date firms. In a properly conducted pattern shop and stores, a pattern should not require seeking, and the fact of a firm depending upon the memory of any one man as to where a certain pattern can be found, is most unbusinesslike. Many pattern-makers can doubtless recall the occasions when they have been required to make patterns in double-quick time, because they have been wanted urgently, and the seeker, finding his memory at fault, no time could be spared to search further for them. This, then, is a matter of both expense and delay, to say nothing of the worry and friction such cases cause inside the works, and also to the customer whose requirements as to delivery are not being met.

The timber question, as far as the pattern shop is concerned, is another item that is allowed to have a course entirely its own. The loss caused by waste and neglect on the part of the men and the indifference with which some concerns regard the size of the scrap heap that grows in every pattern shop, must in the course of a year mean a considerable sum out of the possible profits.

Vanadium Steel Invigoration.

In the past, with few exceptions, alloy steels brought into use mainly for high resistance to shock and for high strain against stress, have taken the form of nickel-steel eye bars. In the former, its principal capacity, as in trusses of wide span—the new Mississippi Bridge has a span of 668 feet—compression members have been of nickel steel. It does not appear that any disclosure of defect in this material has called for a change. But the restless spirit of experiment and adventure characteristic of science when it gets into workshops has led to the American Bridge Company turning out vanadium-nickel-chrome steel eye bars, which take their designation from the chief new ingredient. The bars are 14 inches by 2 inches, swelling towards the head to about 2½ inches, the heads themselves being of 34-inch diameter, with holes capable of receiving 14-inch pins, thus leaving a band of 10 inches all round each hole. One of these bars bore a strain of 80,900 lbs., and only gave at 97,100 lbs. with a fracture of cup form, disclosing a silky texture. The form of fracture seems evidence of a uniform strain all round the bar from the plane at which stress was applied; else, the form would have responded to any point where stress was greatest. If this should prove to be a characteristic of vanadium as tested in eye bars, the metal need not be confined to production of eye bars, unless the yield point of elongation quoted at 28 per cent. makes it unsuitable for other purposes.

The First Norwegian Electric Steel Works.

HIORTH'S ELECTRIC FURNACE.

In a lecture before the Polytechnic Society at Christiania, Mr. Albert Hiorth referred to the valuable work done by the Norwegian Electrical Committee. How rapid the development of the industry had been was shown by the fact that, as late as 1905 very few furnaces were at work, while the total number now in operation was about 60 The average capacity had also increased from 1 ton to 8 tons, and several of larger capacity were under construction. Having thought that Norwegian capital might take an interest in an electric steel works project, he (Mr. Hiorth) obtained offers for a licence from several of the owners of patent furnaces, with the view of erecting one or more steel works in Norway. But the royalties demanded were too high, and what was still worse, the production was limited to a certain maximum, probably owing to fear of competition. All this, in addition to some opposition, resulted in his not succeeding in obtaining the necessary capital at home, and he was obliged to apply abroad after having constructed and patented a new type of a combined induction and arc furnace. A waterfall was subsequently acquired at Helleren, in the Jössingfjord, between the towns of Flekkefjord and Egersund, in the south-western part of Norway, and the necessary work of harnessing the fall and erecting the plant was started forthwith.

By harnessing a waterfall having a high head a horse-power-year may be obtained at one-fifth to one-tenth of the cost of power generated by means of large steam or gas engines, provided always that the power is obtained directly and not through a "middleman" in the form of a power company. In several cases in the western part of the country the first cost of plant per electrical horse-power varies from £5 10s. to £6 12s., and the cost of a horse-power-year is about 16s. 6d. The corresponding figures in the estimates of the Swedish Government for the waterfalls at Trollhättan are £7 10s. and 18s. 7d. This question of cost of power is a matter of vital importance, especially in the profitable manufacture of the inferior qualities, such as structural steel.

The power station is equipped with a turbine and generator which supplies current at a tension of 250 volts and 12½ periods, which is conveyed by copper cables of 1,000 square mm. cross-section.

The furnace now used at Helleren for the making of tool steel is shown in Figs. 1 and 2. This furnace has been constructed to the design of Engineer C. W. Söderberg, and the whole plant, including power station, furnace, and the complete outfit, has been delivered by Norwegian workshops. Many useful experiences have been gained during the construction and experimental working with the first furnace, especially in regard to the fireproof lining. Once or twice it happened that magnesite, which is one of the best fire-resisting materials known, succumbed to the heat and melted. The power-factor has usually varied from 0.75 to 0.8, and as an exception even the value of 0.84 has been reached.

From tests undertaken in workshops at Stockholm and at Sheffield, the steel has been proved to be fully equal in quality to the best Sheffield crucible tool steel.

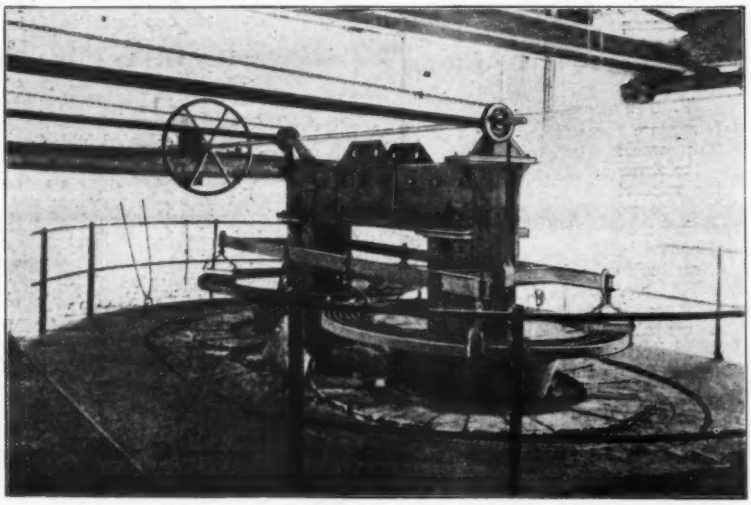


FIG. 1.—HIORTH'S ELECTRIC FURNACE FOR MAKING TOOL STEEL.

VICKERS, SONS & MAXIM, LIMITED.—At an extraordinary general meeting of the shareholders of Vickers, Sons & Maxim, Limited, it was decided to alter the name of the firm to Vickers, Limited. The company was registered in 1867 as Vickers, Sons & Company, Limited, and in 1897, on the absorption of the Maxim-Nordenfeldt Guns and Ammunition Company, Limited, the name was changed to that of Vickers, Sons & Maxim, Limited.

The Manufacture of Foundry Coke.

British Foundrymen's Association: Birmingham Branch.

There was a large attendance at the Technical School, Suffolk Street, Birmingham, on Saturday, February 25, to hear a Paper by Mr. S. W. B. Stephen on "The Manufacture of Foundry Coke Past and Present." Mr. C. Heggie presided, in the absence of Mr. Hiorns (Branch President), who, it was explained, was just recovering from an illness. It was hoped that he would shortly be sufficiently restored to resume his duties.

The following were elected Associates of the Association:—Messrs. W. Young (Bearwood), H. Povey (Smethwick), J. Butler (Birmingham), and John Hall (Birmingham).

Mr. Stephen's Paper was illustrated with excellent limelight views. He traced the origin of the manufacture, explaining that coke originated in the time of Dud Dudley, who was compelled to find another fuel, owing to the dearness of charcoal. Coke was, therefore, employed for the smelting of iron in the blast furnace. One of the earliest furnaces at which coke was used was situated near Ironbridge, and the remains of this furnace were still to be seen. Coke was defined by the speaker as the carbonaceous residue of coal. One of the earliest coking ovens was at Pensnett, near Dudley, the shape of these ovens resembling a beehive and so causing that name to be applied to that type of oven. In the earliest days the fuel was burnt for 96 hours. Later on the beehive oven was constructed with flues underneath, and, as time went on, the waste heat was utilised for accelerating the coking process. For the type of oven having bottom flues, the coking period was 48 hours, and for patent ovens 30 hours. The most important development in coke production was the introduction of the by-product plant and the utilisation of the gases for driving engines and machinery. The lead was taken by the Germans in the development of the by-product arrangements which constitute the principal feature of what is known as the patent oven, but it was not till 1880 that really good results were obtained from such ovens. Various types of ovens in use were shown by the lecturer. The illustrations covered all the types of plant in use in this country, and the various details were pointed out in a lucid way by Mr. Stephen. The general principle of the patent oven was the same in practically all cases, the arrangement of the flues being the essential point of difference. There was a great prejudice against coke which came from the oven in a black condition, but the great desideratum was to have a coke low in sulphur, and coke should, therefore, always be made from washed fuel. Impurities were greatly lessened by the elimination of the various chemicals always mixed with the coal. Sulphur could never be completely expelled, although many inventions had been introduced for reducing the amount. With patent ovens the cost of labour was less than with beehive ovens. Constant operation was necessary with the patent oven, including work on Sundays, otherwise the temperature of the oven would fall, and the coke would not be properly burnt. That would be a great drawback for cupola work, involving higher consumption of fuel. The coke should be both hard and porous. A small percentage of ash would add to the mechanical strength of the coke. If coke was slaked inside the oven it retained the silvery appearance generally valued, but if slaked outside a great deal of that was lost. Friability determined the relative size of the pieces of the various cokes. The denser the coke, the larger the pieces that could be employed, while under some conditions increased density necessitated the use of smaller pieces, but a coke might show a very small amount of friability without being in the least dense. On the other hand, a dense coke must be hard if it was to be of any use. The

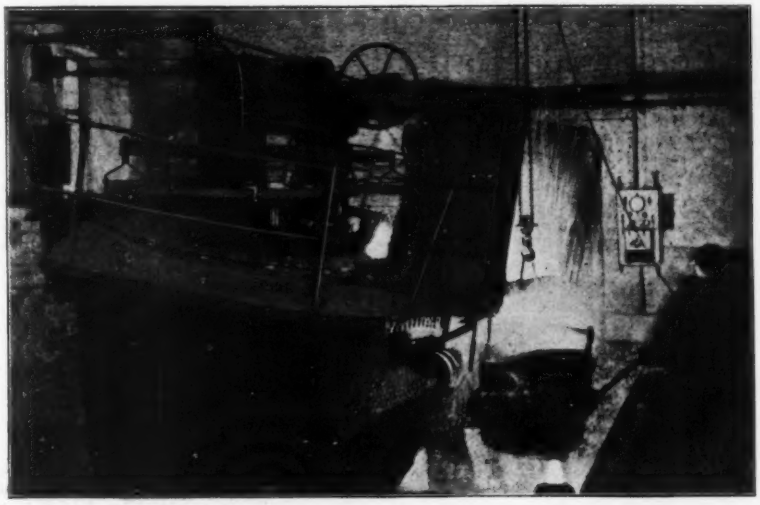


FIG. 2.—HIORTH'S ELECTRIC FURNACE FOR MAKING TOOL STEEL.

disadvantage of friable coke was due to the amount of small made in transit. A short method of estimating the value of coke would be to take a couple of samples and rub them together. That kind might be concluded to be the best which gave the smallest loss in rubbing, that is presupposing the cokes were equal in purity. Resistance to pressure depended upon the quality of the coke, the quantity of ash it contained, and particularly the quantity of slack. The increase of density in cupola coke tended to promote the formation of a large quantity of carbonic acid in combustion. Foundry coke must accordingly be as dense as possible. It was not always possible to draw conclusions as to the quality of coke from its colour, and the appearance of many cokes was spoilt by the use of dirty water in quenching, which caused deposits on the coke and gave it a nasty, foul appearance. The greater the purity of the water used in quenching, the better the appearance of the coke. Good coke should have a sort of metallic ring; a dull, heavy ring always indicated an inferior quality. The purer the coal used the purer would be the coke. There was no doubt that patent ovens were rapidly displacing the old-fashioned type, and the disappearance of beehive ovens was only a matter of time. They would soon be absolutely non-existent. A firm which put down a number of old-fashioned ovens only five years ago had already discovered that from a commercial point of view they were a mistake. In conclusion, the lecturer remarked that he had not gone into the question of by-products, on the ground that they were not particularly interesting to foundrymen.

Discussion.

Mr. R. Buchanan remarked, that on the whole, he thought foundrymen in that part of the world had not a great deal to complain about in regard to the quality of coke, if they compared the sulphur content with that of many American cokes. Englishmen were altogether in a more satisfactory position than American foundrymen. He had sometimes wondered why makers of coke should only use ground material. No doubt formerly it was somewhat of a necessity that the material should be finely ground, but he had with him some of the coke that he received that day, and which was made from lump coal containing 94.47 of carbon. He concluded that coke, being made from coal, would so increase the cost as to make it prohibitive for the founder's use. Seeing also that there was a great amount of fine dust, some of the impurities of the coal might possibly get into it. With regard to the necessity of coke containing a fair percentage of ash, he had never found any difficulty in using coke with a low percentage of ash. If the makers of coke increased the percentage of ash with a view to helping foundrymen to carry their charges, personally, he would be willing to do with something less.

Mr. Fox-Allin said that the subject was one which might very well arouse a considerable amount of discussion. He should like to emphasise the fact that the quality of the coke might be materially affected by the adopted method of quenching. To insure the best results from the material, it was essential that complete quenching be accomplished with a minimum quantity of water and with as little delay as possible. To this end, quenching water, at any rate, in modern plants, was delivered under pressure, usually about 100 lbs. to the square in., sufficient, in fact, to completely penetrate the charge. But even so it could not be denied that the quality of the coke was more or less adversely affected by exposure to the atmosphere in its incandescent state. He had seen in operation at a north country plant what he might describe as a quenching box which travelled on rails the length of the battery of ovens. It was provided with a perforated floor, which acted as a screen to remove the smalls and also to let any surplus water drain away. This floor was revolved by gear as soon as an oven was discharged into the box, and water was sprayed under pressure on to every portion of the incandescent mass. The appearance of the coke so made left nothing to be desired and—a most important consideration from the makers' point of view—the percentage of smalls was very low. Mr. Buchanan had made reference to grinding the material to powder instead of coking large coal. That, in the main, was a commercial consideration. In the first place it might be said that we can find a more profitable market for most of our large coal; indeed it was the facilities they afford for the utilisation of the smalls which made the modern coke ovens such valuable auxiliaries to the colliery. But there was another and perhaps not less important consideration, and that was the facilities afforded for "marrying" the material, which was not commercially possible with the beehive oven, as two or three qualities of coke might be made at one charge, and the consumer would naturally insist upon his coke being maintained at the highest of these qualities. Complete disintegration was, therefore, necessary for two reasons; first to ensure a true, homogeneous mixture of the material, and to permit of ramming, and incidentally the complete utilisation of the oven space, which would, needless to say, not be possible were lump coal employed.

Mr. F. J. Cook said he must re-echo Mr. Buchanan's remarks as to the superior quality of coke sold in the Birmingham district. Nothing struck him so much as that fact when first he saw the analysis of the American cokes. If they would refer to the report of the committee which met in America last year for the purpose of obtaining a standard specification of coke they would be struck with the difference. Certainly not a truck load of American coke would be sold in the Birmingham district, for local consumers would not look at it. The American coke contained 80 per cent. of total carbon as against never less than 90 per cent. in the Birmingham district, where sometimes it reached 93 per cent. There was no difficulty in getting the latter percentage, and, whereas the American ash represented 11 to 13 per cent., the local fuel did not contain more than 6 to 8 per cent. On the point of sulphur again, the Americans had 1 per cent., as compared with 0.6 to 0.8 per cent. in Birmingham. The district was really as well supplied as any place in the world, and a large quantity of the coke came from the Accrington district, repeatedly referred to by the lecturer. Mr. Stephen had spoken strongly in favour of a dense coke for foundry work, but he did not agree with him, because a dense coke would weigh heavily and would, therefore, increase the cost. A coke with 6 per cent. of ash would have the requisite stability which would prove economical, and was strong enough for any cupola used in that district turning out ten tons per hour. What they wanted was a coke as light as possible, with the right quantity of pore space, sufficient to stand the work, but it was not necessary that that coke should be dense. He believed that in Mr. Moldenke's Paper the total carbon was given as 80.4. with 1 per cent. of sulphur and 13 per cent. ash.

Mr. R. Mason said Mr. Stephen had done the right thing in addressing foundrymen on that subject, because they wanted to get in touch with those who supplied the articles they used. He could now understand the meaning of the coal-grinding arrange-

ments. Foundrymen ought to pay less attention to what was said by salesmen about the silvery metallic appearance. Although they admired it so much, it had no value except to the seller. He did not agree as to the necessity of a strong coke to carry the charges, although that was a point insisted upon in the text books. The only time when they found coke being broken up because of its softness, was with the first two or three charges, when the cokes were low down in the cupola, and were smashed by the pig-iron falling upon them; but that was overcome as the fuel rose in the furnace. He had found it a good plan to obviate that by dropping some flat pieces of scrap iron on the top of the coke, to take the first shock of the falling pig-iron. The grinding to dust of the coke in transit was an annoying matter, and he had known as much as 3½ cwt. of useless dust to be produced in a single journey. That might be a point in favour of a hard, firm coke. He did not agree with having very large pieces of coke, and it was a great mistake to throw in the coke in the large lumps in which they came from the by-product ovens. They should be broken down to a moderate size, say about 4 inch cubes.

Mr. G. Hailstone said he disagreed with the lecturer on some points. He did not consider there was any great advantage in using beehive coke in the foundry, because, in the first place, it was too expensive, and in the second place it was too dense. The best results he had ever obtained had been from patent-oven coke. He was rather surprised Mr. Stephen had not supplied the specification of the cokes made in the ovens exhibited and described. A good coke should contain about 6 per cent. of ash, not more than 0.6 of sulphur, and 90 per cent. of fixed carbon. The moisture depended on the weather through which the coke travelled in transit. The question of pore space was very important, not only in regard to the ratio of a pore space to the solid portion, but in regard to the size of the pores. A good coke should contain about 60 per cent. of solid matter, and about 40 per cent. of pore space, and such a coke, when thrown into water, should float. It was possible to have that proportion of pore space in a coke that would sink, but in that case the pores were too large, and that made the coke an inferior one. He would like to know how long was required to produce the coke in the beehive oven and the patent oven. He did not agree with Mr. Cook that there were plenty of cokes to be got in that district containing 6 per cent. of ash. He was afraid they were rather few, and, probably, only two or three to be depended upon. They might get a truck of the other brands occasionally with 6 per cent. of ash, but most of them, including beehive coke, would be found nearer 10 per cent. With regard to the breaking of the coke in the cupola by the first charge of iron, he should recommend the use of the largest pieces of coke that could be found for the bed of the cupola, because they would not break up so easily as small pieces. Mr. Stephen had advocated a dense coke for the cupola in preference to a more porous coke. He presumed that was because, as stated by Dr. Moldenke, the use of a porous coke caused the formation of carbon monoxide, a gas which they did not want in the cupola; whereas if they got a dense coke, the coke was completely burnt, and they only got carbon dioxide. But he did not agree with the preference for a dense coke on that ground. Of course, there was a tendency in the cupola with a porous coke for carbon monoxide to be formed, but he did not think they lost any heat in that way. The heat that was absorbed in the splitting up of the dense coke was not more than the heat wasted in using porous coke.

Mr. Lisle said he preferred to use a lighter coke for the first filling and the denser coke after, but if they used a less dense coke they must reduce their blast.

Mr. H. Pemberton remarked that the question of dense as compared with porous coke was a very debatable one. Personally, he was in favour of a dense coke, and he did not agree with Mr. Hailstone that coke should float in water. They found there was a large amount of carbon monoxide formed with porous coke, involving a large amount of waste. Therefore he did not think it was advisable to use a light coke; they would not get full results from the cupola. With regard to ash they did not need ash to give them a dense coke—they wanted carbon. They would be all the better pleased if the ash were left out. Very little had been said about sulphur, which was a very detrimental element. Very often they found it too high in coke. That might be because sufficient attention was not given to the washing. Anyhow, they wanted it as low as possible. He preferred a fairly hard coke, and a dense coke with ash as low as possible. No doubt it was true that the silvery appearance of the coke was a very deceptive thing. Coke should not be over large. They got it from patent ovens in about 4-in. to 6-in. cubes, which gave the best results for cupola work.

At this stage a discussion arose as to the testing of gases in the cupola, and Mr. Hailstone showed by blackboard sketches how the cupola might be tapped at various points for analysis of the gases. Other speakers joined in the discussion of this matter and eventually Mr. Buchanan pointed out that the discussion was getting on to the subject of cupola practice. At his suggestion this subject was postponed for a discussion on a special evening.

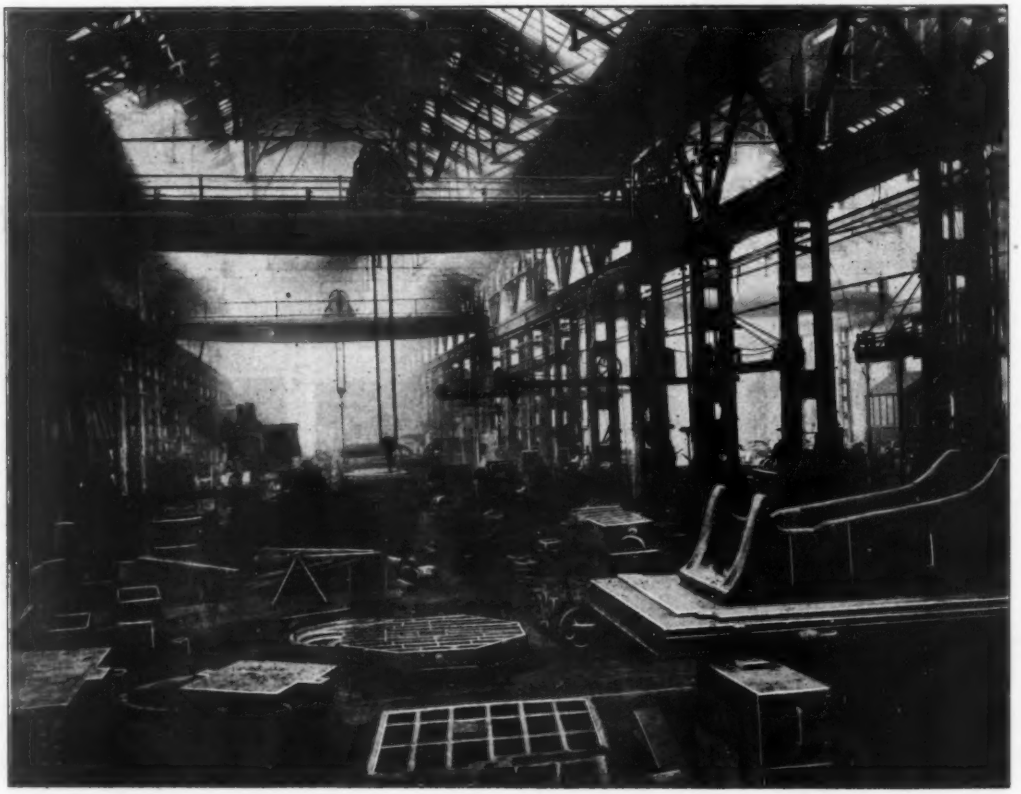
Mr. Stephen, replying, said the reason why coke was not made from lump coal, was on the ground of expense. The colliery proprietor had to make the best of his wares, and coal was taken out even to the size of pearls to $\frac{1}{16}$ of an inch. The slack was washed, and only that suitable for coke because of its caking nature was used. Mr. Fox-Allin had pointed out the unsuitability of large coal for the patent ovens, which were coming more and more into vogue to the certain exclusion in a few years of beehive ovens. In reply to Mr. Cook he would point out that dense coke was not necessarily heavy, especially if the pores were regular. He thought it was proved by foundrymen, from experience, that dense coke was the more economical form of coke. From the commercial point of view they could not disregard the economical factor. He thought Mr. Hailstone's remarks about pore space entirely supported his (Mr. Stephen's) contention. The long period taken in coking was necessary to secure the hardness desired by foundrymen. While there was no doubt that sulphur was injurious, its elimination was practically impossible even by washing. A certain proportion of sulphur constituted a component part of the coal and no coal was non-sulphurous. If they could get coke down to 0.5 they were doing well. Very few coals on the market would give as low as 0.3. Usually 30 cwts. of coal would be required to make a ton of coke. Some of the sulphur was destroyed in the process of coking. If they did not exceed 0.6 per cent., they would not have much to grumble at. No doubt the coals of the district were very low in sulphur compared with American coals. Judged by American standards the local men had much less to contend with than Americans. He valued their appreciation of his Paper, and intended in future to go further into the subject, adding some details.

A hearty vote of thanks was accorded Mr. Stephen on the proposition of Mr. Cook, seconded by Mr. Mason.

Foundry of Crossley Bros., Ltd., Manchester.

Visit by Lancashire Foundrymen.

The widely extending use of the internal combustion engine was impressively brought to the minds of the members of the Lancashire Branch of the British Foundrymen's Association on Saturday March 11, 1911. On this occasion a party of about 60 or 70 visited the works of the well-known firm of Crossley Bros., Limited, at Openshaw, Manchester. The party included Messrs. R. W. Kenyon (Branch President), W. H. Sherburn (Past-President), F. Penlington (Vice-President), H. Sherburn (Hon. Secretary), and J. E. H. Allbut (General Secretary). On arrival at the works the party was met by the general manager, Mr. P. W. Leisham, and a number of his assistants. The company was then divided up into sections and the tour of the works commenced.



View in General Foundry; Works of Crossley Bros., Ltd., Openshaw, Manchester.

The pattern shop was first visited and here some fine work was in progress; a variety of interesting machinery was explained, including a new machine particularly adapted for the production of core boxes and similar articles without the necessity for hand work and at a greatly increased speed. Attention was also called to a new band-saw recently installed, in which, by means of an attachment in the head of the machine, the tension on the saw blade was so regulated under all conditions that the trouble with broken saws had been considerably reduced. Patterns of various engine parts having been described, the smithy was then passed through on the way to the foundries, and although wanting the fascination which it would have had with work in full swing, sufficient of the work in hand (connecting rods, cranks, etc., of all sizes), and the means by which it was handled, was to be seen to give some idea of the skill and thought employed in the operations.

The first of the foundries to be visited was the plate moulding department, in which all the castings that can be produced from plate patterns are made. The building is about 200 ft. long with the roof in one span. Pattern storage is available at one end of the building and a travelling crane commands the whole of the floor. Although it has been found that the class of castings generally produced by this department can be made as cheaply by hand as by any other system, a moulding machine has been recently installed for the production of certain castings and is giving satisfaction. The cupola is placed at the end of the building and is

of the standard type having a capacity of 4 tons per hour.

The general foundry which was next inspected, is a building much larger than the plate foundry. The building is divided into three bays and is provided with light overhead travelling cranes of 5 to 25 tons capacity. There being a considerable amount of cored work in this department, ample drying facilities are available. The melting arrangements comprise a "Whiting" cupola with a capacity of 9 tons per hour together with two smaller cupolas. Partly completed moulds for engine beds, cylinders, liners, etc., were seen and discussed with considerable interest, and the members generally were loth to leave this department.

Passing from the foundry the machine shops were then entered. Here a perfect maze of machinery greeted the eye; lathes of every description, arrays of slotting, planing, milling, drilling, grinding and other machinery of all types, mainly automatic, all arranged with precision and attention to every detail, so that the process of manufacture carries all the various parts in one direction, and no disturbance is caused by passing and repassing. The production of crank shafts from the crude forgings was seen in its various stages. Needless to say, the use of high-speed steel has entered largely into the various processes of machining.

Passing from the general machines, the visitors were then conducted into the department where are arranged the smaller automatic milling and other machines for dealing with the lighter and smaller fittings which contribute to the completion of the modern gas or oil engine.

The brass foundry next came under notice. This is a lofty and well lighted building served with a battery of eight coke-fired crucible furnaces. Provision is made for bench and floor moulding, and castings in bronze, brass and aluminium are produced. The capacity of this department is about 5 tons per week, chiefly light castings, as will be understood.

The erecting shops were then visited and all types of vertical and horizontal engines were seen in construction. The production of producer plants also forms an important branch of the business. From the gas-engine erecting shop the visitors were conducted to the oil-engine department where all sizes of engines for general and marine work were seen under construction. The repair department was also passed through on the way to the testing shop where all engines are put on trial runs under actual working conditions before being despatched. The tour was brought to a close by visiting the painting and despatch department.

Before leaving the works the members assembled and the President expressed thanks to Messrs. Crossley Bros., for allowing the visit to take place, and also appreciation of the kindness of Mr. Leishman and his assistants in devoting their Saturday afternoon to conducting the visitors and explaining the details of the works.

Mr. J. E. H. Allbut seconded the vote of thanks, and said how much the visit had been appreciated. The vote was heartily endorsed by the members.

In response Mr. Leishman said they were very pleased to have a visit from an educational body such as the B.F.A. He remarked that one sometimes heard much about the decadence of British industries, but so long as there were numbers of persons taking such interest in their business as the members of this Association appeared to be doing, there need be no fear for the future position of the trade of this country. Speaking for himself and his assistants it had been a pleasure to meet the members and explain the various parts of the works. They were amply repaid by the intelligent interest that had been shown in all that had been seen.

The National Physical Laboratory.

On Friday last the General Board of the National Physical Laboratory, Teddington, entertained a large number of visitors, representative of the technical and scientific world, and conducted them over the various apartments of the Institution. It was apparent to the visitors that since the last public visit of this description considerable advancement had been made with the buildings and departments, though a number of improvements are still in progress.

According to the Report for the year 1910, in the Department of Metallurgy and Metallurgical Chemistry the systematic investigation of the light alloys of aluminium has been carried on vigorously throughout the year. The theoretical work on the constitution of the alloys of aluminium and zinc has been brought to a conclusion, and the results have been described in a paper which will, it is hoped, be read early in 1911. The investigation of the mechanical properties of the aluminium-zinc alloys and also of the ternary alloys of aluminium, zinc, and copper has been carried on to a considerable extent and it is hoped very shortly to present to the Institution of Mechanical Engineers a further report on the properties of the alloys of aluminium and zinc, and it is hoped to include in this report some references to certain striking results which have already been obtained with the ternary alloys. The pressure of other work has prevented the research being carried on as far as would otherwise have been desirable. It was not found possible during the past year to undertake the experiments on the influence of high pressures on the melting points of eutectic alloys, but it is hoped to carry out this enquiry at a later date. Other work undertaken by this department included researches on temperature-density curves, and on the effects of strain at high temperatures.

Work Proposed for the Current Year.

During the current year in this Department it is proposed to continue the investigation of the light alloys of aluminium, on behalf of the Alloys Research Committee of the Institution of Mechanical Engineers. A report on the binary alloys of aluminium with zinc will, it is hoped, be completed in the first half of the year, while a considerable amount of work on the ternary system aluminium-zinc-copper has also been done. This is to be completed. It is proposed to continue the eutectics research on the lines laid down in the previous programmes; particular attention is to be devoted to the study of the effects of strain on eutectic and nearly eutectic alloys. A number of interesting observations of this kind have already been made on alloys of lead-tin, tin-bismuth and copper-silver, and these are to be followed by experiments on other binary and ternary eutectics. It is probable that the preparation of these eutectic alloys may necessitate the study of the constitution of some of the alloys to be examined. The research on the structure of iron and steel at high temperatures is to be followed up on the lines indicated in the programme for 1910, but with modifications. In addition it is proposed to undertake experiments in etching specimens of steel at high temperatures by gaseous reagents, long strips of steel kept at a temperature gradient being employed in order to show all the transition stages on a single specimen. The causes of brittleness in pure iron and mild steel are to be studied in connection with the previous research which has already elicited some facts bearing on this question.

Overlapping in Patterns and Moulds.

By Joseph Horner.

The trained eye of a pattern-maker or moulder can always detect from an examination of an untooled casting the lines of the mould joints. These may be just the finest possible raised lines encircling the castings, which are indications of the close jointing of the moulds, as in Fig. 1, or they may be wire fins possessing more or less substantial thickness, Fig. 2, which are the sign of joints slightly open. Or there may be overlapping of the metal between one part of the mould and another, Fig. 3, which is bad, a visible proof of want of alignment between the two parts of the mould, just as though one had been pushed laterally in relation to the other, or along the plane of the joint. The first is unavoidable in any mould, but it is of no moment whatever; the second, unless the fin is very thick, simply entails a little more fettling. If, however, the thickness of metal has to be reduced finely, as in very light iron and brass work, the fin involves an extra addition to the thickness of the metal by the amount of the thickness of the fin, which would in such work be objectionable. The third-named condition is bad, not only because of the unsightly appearance it imparts to the casting, but also on account of the differences it produces in the thicknesses of the metal on opposite sides of the joint line. This overlapping may be and often is also combined with a thick fin, which enhances the trouble.

FIG. 1.

FIG. 2.

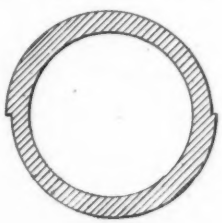


FIG. 3.

SHOWING TYPICAL JOINT FINS ON CASTINGS.

Overlapping may be caused by a similar condition in the joint of the pattern, or if the pattern is true, and even if it is unjointed, overlapping may be produced by bad fitting of the flask parts; or each cause may be equally contributory to the result. We may consider these—the bad fitting of patterns and the loose fitting of box parts—separately, as they have no relation to each other.

Overlapping in pattern joints is due to bad fitting, to looseness due to wear of the devices used in fitting, or to alteration in the dimensions of the parts. The methods of fitting are dowells, skewers, dovetails, or equivalent devices, as screws, nails, notched parts, etc., anything in short which is employed for retaining temporarily during ramming one portion or portions of a pattern in relation to another. Of these the dowell is the principal, and the best when it can be employed, as in separation of parts and lifts effected vertically. Dovetails and skewers are the best for loose pieces carried on the sides of patterns where one portion has to be lifted vertically, leaving the other to be withdrawn laterally. Screws are very suitable for either position when they can readily be got at for withdrawal. Loose nails are almost always objectionable.

Dowells must fit exactly, yet without being in the least degree tight. They are tapered in order to have freedom of delivery directly the pattern joints are separated. Wooden dowells can be lubricated with blacklead. Wood is not enduring, and the dowells wear by the friction of the sand, so that metal dowells, of brass or of malleable cast iron, are much better and more permanent. Moulders sometimes use the dowell holes as rapping holes, and that soon loosens the parts. When dowells become slack they should be replaced Skewers become loose in their holes in consequence of the enlargement of the holes by friction of the wires and sand. When they become very slack the holes can be plugged and fresh ones made, or skewers of the next larger size of wire can be substituted. Dovetails having large bearing surfaces do not wear much. They are usually reserved for high-class standard work, and are, moreover, only suitable for loose pieces which lie next the lowest edges of patterns.

Edges of patterns may overlap in consequence of unequal shrinkage, or expansion of the timber when they have not been properly constructed by lagging, or building up, in a manner suitable for the pattern. When that happens the edges must be dressed off, or the pattern patched, or otherwise corrected according to its shape and dimensions. Brass moulders lessen the risks of overlapping pattern joints by using solid patterns laid in recesses in a joint board, or an odd-side. Then the only risks are those of looseness of the box-pins. This is often guarded against by hinging the boxes.

The overlapping due to badly-fitting flask parts is caused by the pins fitting loosely in their holes, being precisely analogous to the case of pattern dowells. The flasks being rammed in one position, the pattern parts and moulds are accurate then. But when the flask parts are closed finally for pouring, the slack or slop of the pins and holes allows of their flask parts occupying slightly different relations, and the mould parts overlap. This must be prevented by accurate fitting of the pins, and their renewal when they become worn so much as to permit of overlapping.

An old device to avoid the replacement of worn pins is by setting the loosely fitting box parts in a definite relation, as by giving them a twist to pull the pins hard over to one side of their holes. When this is done both at the time of ramming and at closing the mould, parts will not overlap to any very sensible amount. Another way employed without reference to such twist, or in conjunction with it, is

to mark the outsides of the box parts. At two opposite sides an area is whitened with chalk, and lines are scribed across the joint from one box part to its fellow, which lines serve as guides for ramming and closing. A better way is to spread a thin layer of wet loam instead of the chalk, and mark lines across that with the edge of the trowel.

There is in some foundries a large class of heavy work moulded from unjointed loam patterns, in which the top sand almost always breaks away badly near the joint faces, and has to be mended up. The same kind of fracture also occurs in many massive and deep solid patterns of wood. Extensive mending up can scarcely be done very accurately. The best method when practicable is to put the pattern into the top and mend up around it. When there is doubt about the coincidence of top and bottom moulds a good practice is to lay bits of brown paper on the joint of the bottom mould having one edge exactly flush with the edges of the mould. Then moisten the tops of each bit with a drop of clay wash, and lower the top down. The papers will then stick to the sand, and coming up with it will serve as guides for correcting the sand edges in the top mould. One of the difficulties in plate and machine moulding is the avoidance of any overlap in the moulds. Different devices are adopted to ensure that the mould parts shall coincide exactly, even though they are moulded on different plates in different machines. But this is too wide a subject to enter into at the moment.

Foundry Problems.

Discussion by Glasgow Foundrymen.

A meeting of the Glasgow Branch of the British Foundrymen's Association was held on Saturday afternoon, March 11, in the Technical College, Glasgow. Ex-Baillie John King, Glasgow, the President of the Branch, occupied the chair, and he was supported by Mr. Wm. Mair, Vice-President, and Mr. John Ewen, secretary. Upwards of 200 members were present.

The President at the outset explained that the intention that evening was to devote some time to the discussion and consideration of foundry problems. He was glad to know that several members had availed themselves of the opportunity of presenting their difficulties to the meeting, and he was hopeful that the problems which were down for discussion would prove helpful. The first written problem, which had been set down by Mr. J. Wilson, was as follows:—"Is it practicable to make columns 12 ft. long, 5 in. diameter (outside measurement), 1-in. mill, with sand core. My fear is that the core would split. Can any members of the Branch give me information on that point?"

The PRESIDENT said he thought it was almost an absolute certainty that the core would split. If they did happen to get a column he did not think it would be nearly as reliable as under other conditions.

MR. WM. MAIR (Vice-President) said he hardly thought it was practicable to make columns, 12 ft. long under the circumstances set forth in the problem.

A MEMBER said he thought there was no difficulty in the matter at all. It could be done easily enough with a half-inch mill, and why not with an inch.

The PRESIDENT gave it as his opinion that there was a better chance of success with the half-inch mill than with the inch.

This point having been departed from, Mr. Hugh Williamson set the two appended problems:—(1) "What effect has the cupola upon iron, that is as contrasted with the same iron melted in the crucible?"; and (2) How do the same irons compare after annealing: is the expansion equal or otherwise?"

The PRESIDENT observed that perhaps a clearer way of setting the first problem would be to ask if cupola-melted iron had the same fracture as iron melted in the crucible.

The queries did not give rise to a discussion of any importance and the meeting proceeded to take up the following problem which had been handed in—"The centre of a handwheel about 6 in. in diameter, has the hole in the centre bored out and is gated on the centre with a ⅝-in. round gate. The trouble is that a proportion of these castings are unsuitable, being drawn on side of hub. They are machine moulded, a very large output being required at a low cost. No change can be made in the manufacture and the solution must be confined to the iron or sand. A cupola has to be used melting ten tons per hour with a high coke efficiency. Silicon must not exceed 1.50 or 1.75, and the cost of iron cannot exceed ordinary commercial prices."

The PRESIDENT remarked that in this he recognised a very old problem.

MR. MAIR (Vice-President) observed that in his view a little more silicon would make the matter all right, and enumerated the experiments which his firm had carried out, and the difficulties they had encountered.

MR. W. G. MCNEILL thereafter submitted the appended problem:—"The cast-iron water ends of steam pumps on board ship are very liable to corrosion by the action of the sea water. The parts in contact with the sea water appear to get into a condition almost like graphite—in fact you can cut them with a knife. Can the members make any suggestion as to mixing the iron by which this can be overcome?"

The PRESIDENT instanced a similar experience in connection with the Glasgow water mains. He explained how that, by some chemical process, the iron was wholly taken out of a water-pipe in the Bridgeton district of the city.

MR. H. WILLIAMSON asked if the remains of the water-pipes found in the part of Glasgow referred to were ever put through any analysis?

The PRESIDENT replied in the negative. Answering a further question from the same gentleman, he explained that an attempt was made to analytically test the sub-soil.

A MEMBER inquired if Mr. McNeill or the President could tell him what the action of the sea water actually was on the iron?

The PRESIDENT said they all knew more or less what the results were, but he himself did not quite know what the action was.

Several members having given the benefit of their experiences the meeting proceeded to deal with a problem by Mr. W. Morrison which was as follows:—"What effect would you expect in making castings to withstand a pressure of 60 lbs. with No. 4 Middlesbrough iron?"

The question was asked if it was intended to machine the castings in any way, and Mr. Morrison replied in the negative.

MR. GREIG gave it as his opinion that No. 4 Middlesbrough iron would not stand a pressure of 60 lbs.

Contrary views were expressed by several members present and eventually the subject was allowed to drop. In view of the interest which the problems had evoked it was decided practically unanimously to have another "problem night" in the course of next session.

Some Alloys of Aluminium.*

By Fred. C. A. H. Lantsberry, M.Sc.

Aluminium is one of the most abundant of the elements, but it was not until the advent of the electric furnace that it became possible to prepare it in anything like large quantities. It is now manufactured by the reduction of bauxite (natural alumina) in the electric furnace.

Aluminium is a silvery-white metal, which melts at 657 deg. C., and is a good conductor of heat and electricity, its conductivity being about 60 per cent. of that of pure electrolytic copper. Undoubtedly its most interesting property is its extreme lightness, its specific gravity ranging from 2.6 to 2.7 according to its physical condition. Its mechanical strength is, however, very low, but it holds a very high place in the ductility of metals.

In the form of sand castings its tensile strength is only about 5 tons per square inch, in the form of rolled sheets about 9 tons per square inch, while by hard drawing into wire its strength can be raised to 15 tons. In the latter condition it has a yield point of 13 tons per square inch and an elongation of about 25 per cent. It can, however, be rolled into very thin sheets and drawn into very fine wire.

The low density and other useful properties of aluminium have induced many experimenters to attempt to improve the mechanical properties of aluminium, with more or less success, as will be seen in the sequel. The advent of the motor-car and cycle and, still later, the aeroplane, have given a fillip to the aluminium industry, while the shipbuilding industries and the manufacture of cooking utensils open up other fields in which light alloys of strength and stiffness would be extremely useful. Indeed, there are people who consider it not unlikely that there will be an "Aluminium Age" in the world's history.

Although the aluminium-rich alloys are probably of more interest than the heavy alloys containing aluminium, these find considerable applications in the arts, and will be described first.

Copper-Aluminium Alloys.

The high ultimate strengths of these alloys was known to Dr. Percy, who is credited with their discovery. In the very early days of the aluminium industry the Cowle's Company placed high-tension aluminium bronzes on the market, and these found various uses in the arts. During recent years this system of alloys has been subjected to considerable study by Dr. Guillet[1] in France. Messrs. Carpenter and Edwards[2] in England, and Mr. Curry[3] in America. Carpenter and Edwards' research is the most complete, and their results will now be briefly described.

The result of adding aluminium to copper is to cause an immediate increase, not only in the strength, but also in the ductility of the copper. The ductility attains a maximum at 7.35 per cent. aluminium; beyond this the tenacity increases, and the ductility falls, but above 11 per cent. aluminium the ductility becomes so small that the alloys cease to be of any commercial value. Alloys were prepared and tested in the form of sand and chill castings, and the results of tests on typical alloys are shown in Table 1.

* Paper read before the Birmingham Branch of the British Foundrymen's Association, March 25.

TABLE 1.

Aluminium. Per cent.	Form of Casting.	Yield point. Tons per sq. in.	Ultimate stress. Tons per sq. in.	Elongation. Per cent. in 2 inches.	Remarks.
0.10	Sand	3.8	11.5	46.0	
	Chill	4.2	11.34	40.0	
2.10	Sand	3.4	13.5	53.5	
	Chill	3.5	14.0	46.5	
5.07	Sand	4.3	18.1	75.0	
	Chill	3.6	18.8	65.5	
7.35	Sand	6.6	21.3	71.0	
	Chill	5.9	20.1	81.0	
9.90	Sand	11.3	31.7	21.7	
	Chill	13.3	—	—	broke in head
10.78	Sand	14 1	29.5	9.0	
	Chill	27.0	29.21	2.0	

Experiments on heat treating the alloys show that up to 7.35 per cent. aluminium, they are indifferent to annealing or quenching from 800 degrees C. Above 7.35 per cent. aluminium, the alloys are stiffened by heat treatment at 800 degrees C. This is shown by reference to Table 2, which gives the result of tests made on chill castings.

TABLE 2.

Aluminium. Per cent.	Treatment.	Yield Point. Tons per sq. in.	Ultimate Stress. Tons per sq. in.	Elongation. Per cent. in 2 ins.
0.10	Annealed at 800° C. .	4.9	11.07	41.0
	Quenched ,, ,, ...	4.0	11.3	47.5
2.10	Annealed ,, ,, ..	4.8	13.9	56.0
	Quenched ,, ,, ..	4.3	13.9	55.0
5.07	Annealed . ,, ...	5.1	18.0	61.0
	Quenched ,, ,, ..	5.7	19.1	80.0
7.35	Annealed ,, ,, ...	6.0	20.2	80.0
	Quenched ,, ,, ...	7.3	19.8	79.0
9 90	Annealed ,, ,, ..	16.5	26.4	27.0
	Quenched ,, ,, ...	17.7	38.57	22.0
10.78	Annealed ,, ,, ...	23.6	28.72	nil.
	Quenched ,, ,, ...	26.7	32.36	3.0

During the discussion of the results, objection was made to the representative character of the results on the grounds of the small dimensions of the castings, and in a later research[4], on the suitability of these alloys for castings to withstand internal pressure, Messrs. Carpenter and Edwards have taken mechanical tests of cylindrical castings 9 in. long by 3 in. diameter. The results obtained were quite good, though somewhat lower than the original ones, a 10 per cent. alloy having a tensile strength of 26.23 tons per square inch with an elongation of 13 per cent.

TABLE 3.

Aluminium. Per cent.	Yield Point. Tons per sq. in.	Ultimate Stress. Tons per sq. in.	Elongation. Per cent. in 2 ins.
0.10	6.9	14.5	65.5
2.10	8.6	17.46	56.5
5.07	11.4	26.41	69.2
7.35	10.6	29.08	72.5
9.90	14.8	28.10	28.8
10.78	15.4	33.62	14.0

The effect of mechanical work on the alloys, hot rolling from 3 in. to $\frac{13}{16}$-in. diameter, is to increase the tenacities and ductilities of the alloys, especially those containing more than 7.5 per cent. aluminium. This is shown in Table 3.

Alloys containing below 7.5 per cent. aluminium are not amenable to cold working, but the higher alloys draw well and show a vast improvement in their mechanical properties. The 9.90 per cent. alloy drawn from $\frac{15}{16}$ in. to $\frac{13}{16}$ in. diameter, shows a yield point of 40.4 tons, an ultimate stress of

FIG. 1.—α SOLID SOLUTION.

43.94 tons, with an elongation of 13 per cent. Doubt was expressed at the time, based on the experience of some German workers on alloys of copper-aluminium containing some iron, which fell to pieces after some months standing, as to whether these hard-drawn alloys would be stable, but tests made by the author in conjunction with Dr. Rosenhain indicated that these alloys showed no deterioration in properties or "ageing," even after standing several years.

In the description of the above tests it will have been noticed that the alloys appear to divide them-

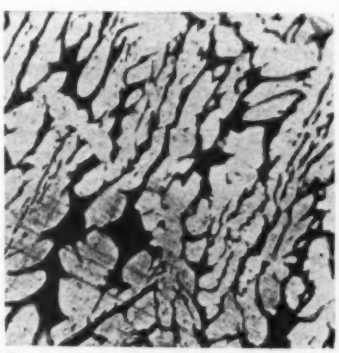


FIG. 2.—α AND β SOLID SOLUTIONS.

selves into two groups (1) containing below 7.35 per cent. aluminium and (2) containing 7.35 to 11 per cent. aluminium. Up to 7.35 per cent. aluminium the alloys consist of a single phase, the α solid solution, which is soft and ductile. Above 7.35 per cent. aluminium a second dark etching phase makes its appearance. This is the β solid solution which is hard and brittle.

It is this phase which contributes to the hardness of the alloys; so much so, in fact, that an alloy containing 15 per cent. aluminium, and hence a large proportion of the β constituent, has a Brinell hardness number of 539, a figure quite comparable with that of a hardened tool steel.

In torsion, the properties of the alloys are very interesting, the 7.35 per cent. alloy possessing the maximum torsional strength of 31.51 tons per square inch with a total twist of 1,374 degrees. The appearance of the β constituent causes an immediate reduction in the total twist, the 9.9 per cent. alloy showing a torsional strength of 31.3 tons per square inch, with a total twist of 234 degrees. Under alternating stress tests the alloys showed almost

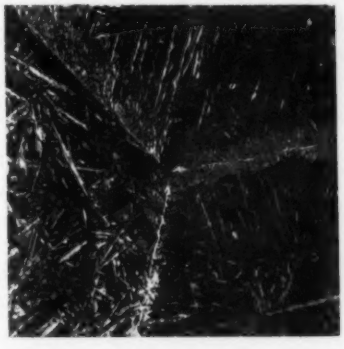


FIG. 3.—CU.-AL. ALLOY, QUENCHED FROM 1,000° C.

marvellous results. Prof. Arnold reported that the 7.35 per cent. aluminium alloy showed a record resistance. Dr. Stanton's test confirmed this result.

A remarkable similarity in properties exists between the 9.9 per cent. alloy and a mild Swedish steel containing about 0.35 per cent. carbon, not only in mechanical properties, but also in microstructure. Both materials show a duplex structure under the microscope which becomes acicular when quenched from high temperatures. The resemblance to the martensitic structure of quenched steel shown in

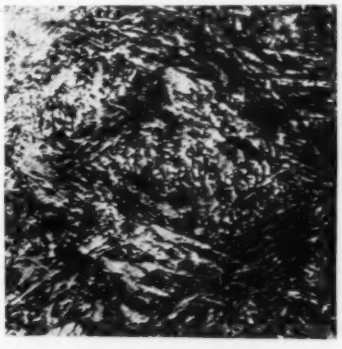


FIG. 4.—MARTENSITE

Fig. 4 is remarkable. Table 4 exhibits the similarity of properties.

TABLE 4.

	0.35 % C. Steel.	10 % Al. Alloy.
Yield point. Tons sq. in.	15.2	14.8
Ultimate stress. Tons sq. in.	38.0	38.1
Elongation. Per cent.	26.0	28.8
Alternating stress range. Tons. $\frac{\text{Tension}}{\text{Compression}}$ =	1.4 29.5	28.3
Izod test (ft. lbs. absorbed)	4.3	4.5

The aluminium bronzes show a remarkable superiority, however, in their resistance to corrosion over mild steel and such alloys as Muntz metal

and Naval brass. This has been shown conclusively by experiments both in the laboratory and the open sea, ranging over a period of several years. In the sea, an alloy containing 10 per cent. aluminium decreased at the rate of 0.00081 lb. per square foot per 30 days, while Muntz metal showed a loss of 0.0023 lb. under the same conditions. In this connection it is interesting to note that while Muntz metal corrodes at practically a constant rate, the aluminium bronzes show a considerable falling off in the rate of corrosion after a few months' time.

In a recent research Messrs. Carpenter and Edwards have shown that if sound castings of these alloys are obtained they are eminently suitable for the production of castings to withstand hydraulic and steam pressures. The alloys do not appear to deteriorate with time, as is the case with other alloys used for this purpose.

One of the chief difficulties encountered in dealing with these alloys lies in the formation of a dross or skin of alumina which appears to be almost elastic, and defies all efforts to remove it. This alumina is produced partly by the reduction of copper oxide, and partly by atmospheric oxidation. It was considered, therefore, that this difficulty could at all events be partly removed by reducing the copper oxide before adding the aluminium, and accordingly in conjunction with Dr. Rosenhain[5], the author took up the further study of the alloys on these lines. On account of the direct improvements effected by the introduction of manganese to ordinary bronzes and brasses, this element was chosen for the earlier experiments, and though improvements were effected, they were not so great as were expected.

As a hardening agent manganese possesses the same effect as aluminium, but not to the same degree. Three per cent. of manganese can be added to the 10 per cent. aluminium bronze, and 5 per cent. to the 9 per cent. bronze without seriously embrittling the alloys. The low aluminium-manganese alloys are very disappointing, and only those containing over 8 per cent. aluminium can be regarded as possessing technically useful properties.

Alloys containing much above 5 per cent. manganese were found to flow sluggishly and to be very likely to give unsound castings. In every case chill castings were superior to sand castings, and the mechanical properties were very much improved by mechanical work such as rolling and drawing. The mechanical properties and compositions of a few of the most promising alloys examined are shown in Table 5.

TABLE 5.

Composition.		Condition.	Yield Point. Tons per sq. in.	Ult. Stress Tons per sq. in.	Elongation. Per cent. in 2 ins.
Al. %	Mn. %				
10.03	0.43	Sand casting	14.28	32.80	24
		Chill ,,	15.92	36.00	24
		Rolled bar ...	19.60	39.40	31
10.02	0.92	Sand casting	19.00	35.76	22.5
		Chill ,,	16.00	39.90	25
		Rolled bar ...	23.04	42.84	22.5
9.99	2.01	Sand casting	13.20	34.44	24
		Chill ,,	16.80	37.00	25
		Rolled bar ...	18.00	41.85	24
8.91	2.98	Sand casting	10.80	31.60	24
		Chill ,,	14.80	34.40	26
		Rolled bar ...	20.60	40.00	39
9.33	3.78	Sand casting	12.24	32.12	20
		Chill ,,	15.14	39.58	32
		Rolled bar ...	18.12	40.52	35

Comparison of this table with Tables 1 and 3 shows that the addition of manganese results in a considerable improvement of the alloys in all forms. By cold-drawing, the alloy containing 10 per cent. Al. and 2 per cent. Mn. can be hardened up to a yield point of 41 tons, an ultimate stress of 52.1 tons, with an elongation of 10 per cent. In this condition it is quite hard enough to cut stone. This alloy should be eminently suitable for bronze gear wheels and for making cutting tools for explosives. In addition, the alloys were capable of taking a very high finish, and, under Dr. Stanton's test, showed a remarkable resistance to abrasion. They should, therefore, find some application as bearing metals, and would, undoubtedly, prove less expensive than phosphor bronze. The effect of the addition of manganese is also shown in the shock-resistance of the alloys. The Izod test shows that while the 10 per cent. aluminium alloy absorbs 4.5 ft. lbs. on fracture, the ternary alloys absorb 10 ft. lbs.

Unfortunately, however, these alloys possess a very low modulus of elasticity, which tells against them in their use in the construction of machinery, more especially in the rapidly moving parts. The modulus of elasticity ranges about 14×10^6 lbs. per square inch, which is only about half the figure given by steel. Herein lies the explanation of the remarkable behaviour of the aluminium bronzes under dynamic stresses.

In the preparation of the alloys it was found that Thermite-manganese and ferro-manganese could be used directly, but considerable advantages are derived from starting from a cupro-manganese alloy. This is done by melting copper under a borax slag saturated with oxide of manganese and afterwards adding the requisite quantity of manganese or ferro-manganese. The alloy is cast into small ingots, and for fine weighing and making up, part of the alloy is granulated by pouring into water. In this way considerable refinement is effected, *e.g.*, starting from an 80 per cent. ferro-manganese, the resulting alloy had the composition :—

Copper, 66.14 per cent.
Manganese, 31.68 per cent.
Silicon, 0.014 per cent.
Iron, 1.86 per cent.
Nickel, 0.36 per cent.
Carbon, 0.053 per cent.

Alloys prepared from this cupro-ferro-manganese contain about 0.31 per cent. iron, which is not present in the alloys of Thermite origin. The result appears to be a slight all-round improvement in the alloys. Little need be said about the preparation of the actual alloys except that it is necessary to add the whole of the cupro-manganese before adding the aluminium, and that the casting is best made in surface-dried green-sand moulds at as low a temperature as possible. As in the case of the aluminium alloys, the use of very large gates is necessary in order to ensure soundness of the castings.

Aluminium is almost an essential constituent of manganese bronzes, in which its function is that of a deoxidiser. An analysis of Parsons' manganese bronze made some years ago by the author, showed :—Copper, 56.72 per cent.; lead, trace; aluminium, 1.78 per cent.; iron, 2.20 per cent.; manganese, 0.52 per cent.; zinc, 37.68 per cent.

Aluminium Brasses.

Aluminium is often used as a partial substitute for zinc in brasses, it having the effect of increasing the hardness and tenacity, and reducing the ductility of brass.

For most of our knowledge on the copper-zinc-aluminium alloys we are indebted to Dr. Guillet[6],

who says that 1 part of aluminium can act as a substitute for 3½ parts zinc. Alloys containing over 4 per cent. aluminium are difficult to cast sound and work, but below this percentage the alloys give excellent castings suitable for pumps, valves, pinions and propellers. Further, the alloys forge and draw well. The effect of aluminium on sand castings of the 70 : 30 and 60 : 40 brasses is shown by reference to Table 6.

TABLE 6.

Composition.			Yield Point. Tons per sq. in.	Ultimate Stress. Tons per sq. in.	Elongation. Per cent.
Cu.	Zn.	Al.			
70.0	29.6	0.0	3.6	8.7	50
69.0	29.9	0.4	2.9	12.6	59
70.0	28.8	0.9	4.2	14.4	67
70.5	26.4	3.1	8.5	21.5	50
70.1	24.7	5.2	4.7	32.2	11
60.0	40.0	0.0	5.1	20.2	47
59.6	40.1	0.3	6.2	20.5	51
59.9	40.3	0.8	6.0	19 6	45
59.6	38.5	2.9	7.5	29.2	14
60.4	35.9	4.7	11.3	28.0	2

The effect of aluminium on the forging brasses, *i.e.*, those containing 40 per cent. zinc, is shown in Table 7.

TABLE 7.

Composition.			Yield Point. Tons per sq. in.	Ultimate Stress. Tons per sq. in.	Elongation. Per cent.
Cu.	Zn.	Al.			
61.4	38.4	0.7	6.4	22.3	45
60.3	38.2	1.1	7.1	24.2	36
61.0	37.7	1.4	7.8	23.3	43
59 9	37.9	2.0	11.5	24.8	17
59.8	37.2	2.7	11.2	28.2	16
60.0	36.4	3.9	11.6	30.5	13

These alloys have been rolled, drawn, and annealed, and the tests bring out very clearly the improvements effected by the addition of 2 to 3 per cent. aluminium to the brasses.

Light Alloys of Aluminium.

The aluminium-rich alloys are coming into great prominence for aeroplane work, in connection with which it will be usual to employ wires and other cold-drawn material for such purposes as stays. It is to be hoped, therefore, that care will be taken to show that the alloys used do not deteriorate by "ageing," for cases are on record of severely strained material falling to pieces in the course of time.

It has already been pointed out that aluminium itself is mechanically weak, but practically the whole of the elements in the periodic table have been added to aluminium with the object of increasing its strength. In his book, "Introduction to the Study of Metallurgy," Sir Wm. Robert Austen says that the addition of 2 per cent. titanium to aluminium produces remarkable results.

Aluminium-Copper Alloys.

These alloys have been very fully investigated by Messrs. Carpenter and Edwards, who showed that the limit of useful alloys is obtained at a content of 8 per cent. copper, and that very little advantage is derived from adding more than 4 per cent. of copper. Table 8 shows the properties and compositions of the alloys in the form of sand and chill castings and rolled bars.

TABLE 8.

Copper. Per cent.	Form.	Yield Point Tons sq. in.	Ult. Stress. Tons sq. in	Elongation. Per cent. in 2 inches.	Remarks.
0.00	Sand casting	2.5	4.9	24.0	
	Chill ,,	2.3	5.22	37.0	
	Rolled bar ...	6.5	7.20	30 5	
1.90	Sand casting	3.3	4 57	5.5	
	Chill ,,	3.9	8.18	17.0	
	Rolled bar ...	12.8	14.36	19 0	
3.76	Sand casting	4.9	7.49	5.0	
	Chill ,,	5.4	9.6	10.5	
	Rolled bar ...	11.6	17.00	21.0	
6.15	Sand casting	6.1	7.72	—	broke outside g.m.
	Chill ,,	5.3	9.92	5 0	
	Rolled bar ...	13 1	17.27	15.5	
8.08	Sand casting	6.5	7.40	—	,, ,, ,,
	Chill ,,	7.2	10.65	—	,, ,, ,,
	Rolled bar ...	11.00	15.31	17.5	

By cold drawing the 3.76 per cent. copper alloy its yield point was raised to 18.5 tons, its ultimate stress to 18.5 tons, with an elongation of 7.5 per cent. Subsequent experiments on rolled sheets showed that the improvement in mechanical properties, due to cold working, was entirely removed by annealing at 500 degrees C. The effect of remelting these alloys is very slight; if anything, a slight improvement in the ductility is obtained. It is interesting to note that the deterioration observed in the heavy alloys does not extend to the light ones. Experiments made on the effect of casting temperature showed that an alloy which, when cast at 650 degrees C., had a yield point of 5 to 6 tons per square inch, an ultimate strength of 9.68 tons per square inch, with an elongation of 8.5 per cent., only showed a yield point of 4.5 tons, an ultimate strength of 4.89 tons, and an elongation of 3 per cent. when cast at 707 degrees C. This clearly shows the influence of casting temperature on the results obtained with these alloys. In fact, there seems to be no class of alloys in which the effect of overheating is felt so keenly as it is in the alloys of aluminium.

Aluminium-Copper-Manganese Alloys.

These alloys were investigated by Dr. Rosenhain and the author, and some preliminary experiments were made on the effect of manganese alone on aluminium.

Some chill castings were prepared, but the results were so discouraging that the experiments were abandoned. The addition of such small quantities of manganese as 2 per cent. destroyed the ductility of aluminium without adding to its strength. Subsequent work of a theoretical nature, shows that manganese and aluminium form a hard, brittle compound (Fig. 5), which appears to be totally insoluble in aluminium. Its effect is, therefore, something like that of sulphide of manganese in steel. Furthermore, this compound rapidly disintegrates, and falls to a powder in the atmosphere. Experiments were, however, pursued in the direction of adding manganese to aluminium-copper alloys containing not more than 4 per cent. copper. Two of the alloys gave very promising results, particularly in the form of chill castings, as will be seen from Table 9.

By cold drawing the first alloy its yield point was raised to 11.28 tons, and its ultimate strength to 18.32 tons, the elongation falling to 6 per cent.

Some interesting tests were made on the effect of casting temperature on the ultimate properties of the rolled bars. Two billets were cast at temperatures differing by 70 degrees C., and were afterwards rolled into bars. The mechanical properties of

TABLE 9.

Composition.		Form.	Yield Point. Tons sq. in.	Ult. Stress. Tons sq. in.	Elongation. Per cent.
Cu.	Mn.				
2.06	1.94	Sand casting	5.8	8.48	4.0
		Chill ,,	6.4	9.06	5.0
		Rolled bar ...	12.13	17.04	16.0
2.89	0.94	Sand casting	6.0	7.48	5.0
		Chill ,,	7.27	12.05	13.5
		Rolled bar ...	12.80	15.50	15.0

the resulting bars were identical, showing that the deleterious effects of casting at too high a temperature are completely obliterated by subsequent mechanical treatment.

The ability of these light alloys to resist shock is repeatedly called into question, and a series of tests were made with the Izod machine, which showed that the two alloys here described absorbed respectively 4.1 and 5.5 ft. lbs. on fracture. Now a steel

FIG. 5.—ALUMINIUM-MANGANESE COMPOUND.

of 0.35 per cent. carbon absorbs 4.5 ft. lbs., so considering the low tenacities of these alloys, in conjunction with the low densities, the results must be considered remarkable.

Experiments on the corrosion of the light alloys showed that the addition of manganese materially decreases the rate of corrosion, both in tap and sea water. This is contrary to a general opinion that aluminium corrodes at a slower rate than its alloys. Possibly the managanese itself is oxidised, and its oxide adheres to the surface of the metal, producing a protecting patina of some hydrated oxide of manganese. This tendency of manganese to increase the resistance to corrosion has been confirmed by Mr. Heathcote, who tried alloys of aluminium with iron, copper, and zinc for a certain purpose, and found that all these alloys were worse than aluminium as regards resistance to corrosion. Ultimately an alloy containing 1.4 per cent. manganese, 0.3 per cent. of iron, and 0.4 per cent. silicon was found to resist corrosion in a satisfactory manner. In the form of 15 gauge rolled strip, such an alloy has a tenacity of 12 tons with an elongation of about 12 per cent.

Aluminium-Zinc Alloys.

Such alloys are undoubtedly those which lend themselves best for casting purposes, and are largely used in castings for instruments, such as electrical meters and so forth. The alloys used in motor-car construction are essentially zinc alloys, containing from 1 to 4 per cent. copper.

Shepherd has shown that the zinc-aluminium alloys at each end of the series form what are known as solid solutions (*i.e.*, the metals remain dissolved in each other in the solid) to a very high degree, and from comparison with the brasses and bronzes, it would be anticipated that such alloys are capable of a high degree of utility. The good casting properties of the aluminium-zinc alloys are attributed by Shepherd[9] and Bancroft[10] to the fact that zinc increases the fluidity and decreases the surface tension of molten aluminium. In a recent research, however, Professors Turner and Ewen[11] have shown that the alloys undergo a slight expansion on solidification, particularly noticeable in the alloys containing 40 to 60 per cent. aluminium. In the same paper information on the effect of zinc on the strength of aluminium is given, and it appears that zinc rapidly increases the tenacity of aluminium, until at a content of about 20 per cent. zinc the tenacity reaches 17.5 tons, after which the tenacity slowly increases to a maximum of about 17.8 tons, at a content of 50 per cent. zinc, and then falls down to that of pure zinc.

The tenacity of 17.5 tons per square inch for a 20 per cent. zinc alloy is somewhat higher than is obtained in actual practice, 15 tons per square inch, with an elongation of 5 per cent. on 2 inches, being a more average figure. In the light of our present knowledge the 20 per cent. alloy is probably the most useful one of the zinc-aluminium series.

Dr. Guillet divides the aluminium alloys into two classes (1) those containing about 15 per cent. zinc which cast well and are amenable to working, being very malleable, and (2) those containing about 30 per cent. zinc, which give very fine castings, but are not amenable to such operations as forging and drawing.

Table 10 gives some idea as to how the tensile strength of aluminium-zinc alloys increases with the zinc content, tests being made on chill castings.

TABLE 10.

Zinc. Per cent.	Yield Point. Tons sq in.	Ultimate Stress. Tons per sq. in.	Elongation. Per cent. in 2 ins.
5	4.5	5.8	17.0
10	5.1	8.9	15.0
15	6.5	11.4	13.5
20	8.0	12.7	6.0

For most engineering work, however, and particularly in alloys for motor-car work, the zinc is either partly replaced or supplemented by copper up to a content of 4 per cent. Favourite alloys are those containing 10 to 12.5 per cent. zinc with 2 to 3.5 per cent. copper. Such alloys have a density of about 3 and give good clean sand castings with a tensile strength of about 10 to 12 tons per sq. in. with an elongation of 6 to 10 per cent. Macadamite is a ternary alloy, for which great strength is claimed. It contains 24 per cent. zinc, 4 per cent. copper ad 72 per cent. aluminium and in the form of chill castings has a tensile strength of 20 tons per sq. in.

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(To be continued.)

A Malleable Iron Foundry's Trolley System.

The use of overhead trolley systems for handling raw material and finished products is becoming more general in foundries. The New Jersey Foundry and Machine Company, New York City, U.S.A., has installed a system in the foundry of the Torrance Malleable Iron Company, Troy, N.Y., which gives a good idea of the standard practice in this respect. Fig. 1 is a plan of the plant showing the lay out of the track, while Figs. 2, 3 and 4 show portions of the trolley system. Fig. 2 shows one of the removable reinforced bottom self-righting and self-dumping buckets used for hauling coal, sand, coke, pig-iron, scrap, castings, sprues, wasters, etc.; Fig. 3 is a view of a portion of the system at the right of the furnace, and Fig. 4 shows a switch and the overhead scale which is used for weighing various loads.

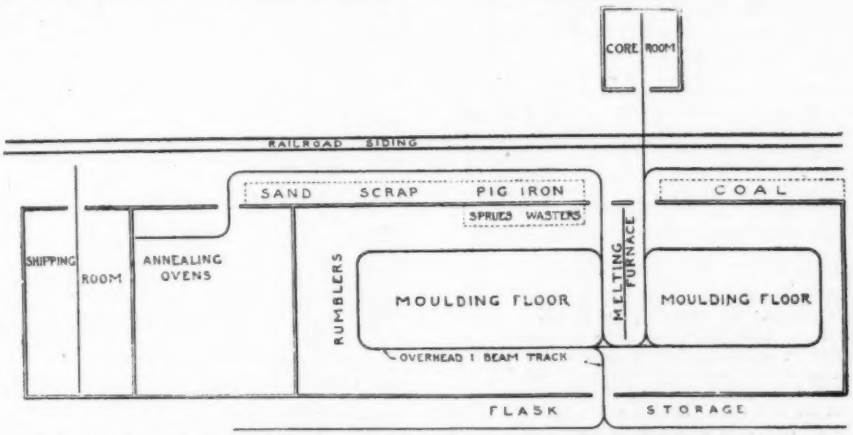


FIG. 1.—PLAN OF TRACK LAY OUT FOR TROLLEY SYSTEM AT THE FOUNDRY OF THE TORRANCE MALLEABLE IRON COMPANY.

As will be noticed from Fig. 1, the flask storage yard is on one side of the main foundry building, the core room on the other, and the furnace is located near the centre of the main building opposite the core room,

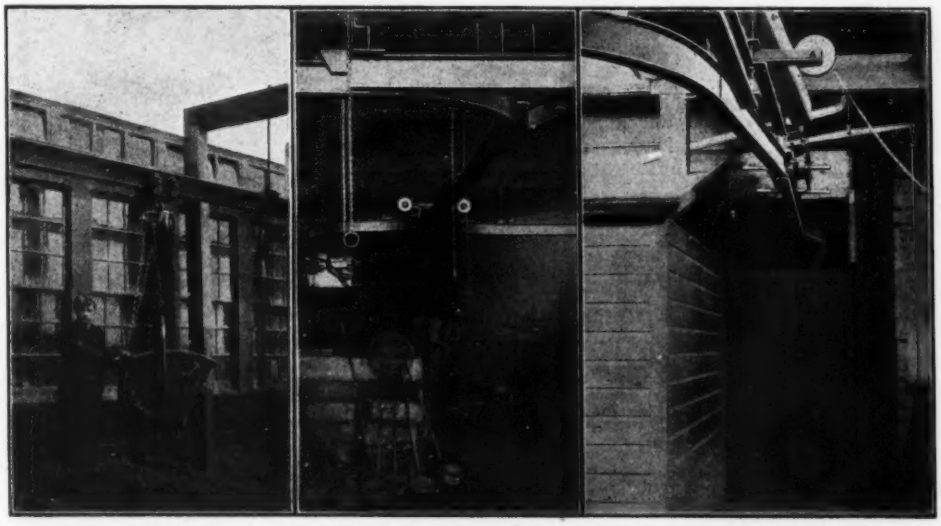


FIG. 2.—ONE OF THE BUCKETS USED.

FIG. 3.—TRACK NEAR THE FURNACE.

FIG. 4.—SWITCH AND OVERHEAD SCALE.

TROLLEY SYSTEM AT THE FOUNDRY OF THE TORRANCE MALLEABLE IRON COMPANY.

The coke, pig-iron, scrap and coal are stored on the side of the main building along the railroad track. The track for the overhead trolley system is a 7 in. I-beam of light section, having a carrying capacity of

from 1,500 to 2,000 lbs. There is approximately 2,000 ft. of track around the plant, which enables practically all handling from the raw material to the shipping room to be accomplished by the overhead trolley, hand handling being used only to a very slight extent. The molten metal is taken from the furnace in bull ladles running on the track. Branches of the system run to the flask storage yard, the core room; the coal, pig-iron and coke storage piles; the annealing ovens and the rumbling barrels.

A special skip, which allows greater control in dumping, is ordinarily employed for handling castings from the moulding bins to the rumbling barrels and the cleaning room. The cores are handled on a special shelf carrier with a top spring connection to eliminate vibration. An independent system having a capacity of more than 1,000 lbs. serves the dispatching room, and there is a short section of track over the furnace with a trolley and air hoist for charging purposes and handling bungs.—"Iron Age."

Death of Lord Airedale.

The death occurred suddenly in Paris, on Thursday March 16, of Lord Airedale, after a heart seizure. The deceased nobleman had been staying at Beaulieu with his son and daughter, and was expected back at his seat Gledhow Hall, Leeds, by Monday, the 20th ult. His Lordship was in his usual health when he left home, and no news of any illness had been received at Gledhow Hall.

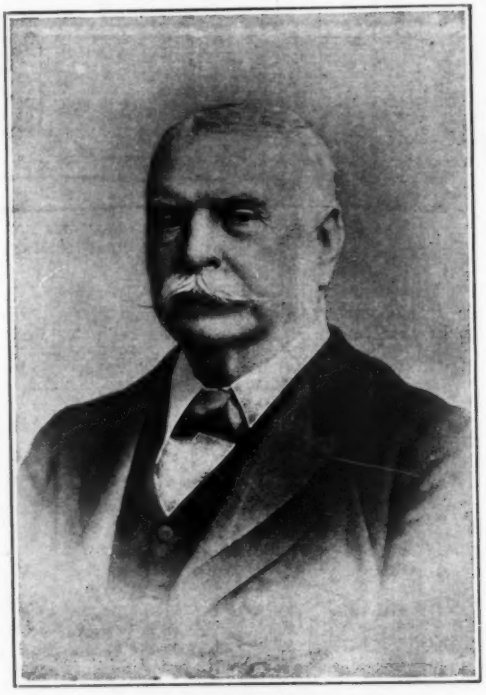
Lord Airedale, formerly Sir James Kitson, one of the most famous of Yorkshire captains of industry, was the second son of the late Mr. James Kitson, of Elmete Hall, Leeds, and was born in that city on September 22, 1835. He was educated at a proprietary school at Wakefield, and afterwards at University College, London. When the railway system began to be developed, his father commenced the production of railway material at Hunslet, and in 1839 formed on a small scale what for many years has been the extensive engineering establishment known as the Airedale Foundry.

The foundry, at the outset, was a very modest affair; Lord Airedale's father employed a total of three men, and had many initial difficulties to overcome. But James Kitson the elder had all the keenness, shrewdness, and all-round business ability that were afterwards displayed by his distinguished son. Orders came in faster and faster, more and more men were employed, and by 1850—when James Kitson the younger was nearing business age—the Airedale Foundry contained 500 hands. It was, therefore, quite a large concern in which the future Lord Airedale served his apprenticeship as a partner. By 1854, he and his elder brother, Mr. F. W. Kitson (who died in 1877) were considered by their father to be qualified for management on their own account. He consequently acquired on their behalf the Monk Bridge Iron and Steel Works, situated in Whitehall Road, Leeds, and installed his sons in authority there.

The enterprise of the Kitson family went from success to success. The 500 employés grew to 1,500, and the total of them did not pause even at that high figure. The output of the firm was varied in character. In addition to general engineering work, boilers, steam hammers, blowing engines, pumping and rolling-mill engines of the largest size were constructed, and several thousands of locomotives were built, not only for home railways, but for most European countries, Africa, South America, nearly the whole of the British Colonies, and India. The Kitson Company were the first in the Leeds district to make steel tyres, and in 1885 they commenced the manufacture of cast-steel wheel centres for locomotives, which, on account of their greater strength and rigidity, gradually superseded the old wrought-iron built-up centres. Appreciation of his position in the engineering world resulted in his election as President of the Iron and Steel Institute (1888-90), and he was subsequently awarded the Bessemer gold medal. In addition to this, he was a member of the Institution of Civil Engineers, and of the Council of the British Iron Trade Association.

Lord Airedale's connection with Leeds was a very close and cordial one. He was Lord Mayor of the city 1896-7, and was made a Freeman about five years ago. He was also at one time President of the Leeds Chamber of Commerce. In 1906 he was sworn of the Privy Council, and some time ago the University of Leeds paid a tribute to his prominence in the engineering world by conferring upon him the degree of Doctor of Science.

As an illustration of his Lordship's active life, it may be mentioned that at the time of his death, in addition to being the senior Past-President of the Iron and Steel Institute, and a member of the Council of the British Iron Trade Association, he was also chairman of Kitson & Company, Limited, Airedale Foundry, Hunslet, Leeds; chairman of the London and Northern



THE LATE LORD AIREDALE.

Steamship Company, Limited; chairman of the Monk Bridge Iron and Steel Company, Limited; and a director of the North-Eastern Railway Company, the London City and Midland Bank, Limited, the London City and Midland Executor and Trustee Company, Limited, and the West Galicia Railway Company.

PARR'S BANK have lately received applications for the purchase of £410,900 equivalent to $2,000,000 of 6 per cent. first mortgage and Collateral Trust bonds of the Canadian Steel Foundries, Limited, at the price of £102 and £100 bond. The present issue of bonds is limited to $3,650,000. Of this amount, $2,900,000 (including the $2,000,000 now offered) have been issued for the purpose of purchasing or acquiring control of and developing the properties of the Montreal Steel Works, Limited, and the Ontario Iron and Steel Company, Limited.

Recent Improvements in Pyrometry.

On Thursday, March 2, a lecture on "Some Recent Improvements in Pyrometry and Other Scientific Instruments," was given by Mr. Robert S. Whipple, of the Cambridge Scientific Instrument Company, at the Birmingham University, to a joint meeting of the Staffordshire Iron and Steel Institute, the Birmingham Metallurgical Society, the University of Birmingham Metallurgical Society, and the Birmingham Branch of the British Foundrymen's Association.

MR. WHIPPLE, whose lecture, was illustrated by means of lantern slides and a large collection of apparatus, with some examples of which demonstrations were given, referred to his lecture given in Birmingham in April last year on "The Recent Advances in Pyrometry," and said that, on the present occasion, he would not dwell upon the scientific side of the question, but would deal with some improvements which he believed would add largely to the value of pyrometers, both as to their suitability for particular industrial processes and as to the scientific accuracy of their results. Mr. W. S. Peake (who was present that evening), had in Peake's compensating leads given them an invention which had done more for thermo-electrical pyrometry than any other invention for the last ten years. When a thermo-couple was made of inexpensive wires, such as copper and constantan (copper 60 per cent., nickel 40 per cent.) the ends of the couple might be carried sufficiently far away from the furnace to make any error introduced by variations of the cold junction negligible in the majority of industrial operations, but when the couple was made from metals of the platinum group it was necessary, on account of the high price of the metal, to reduce its length to the smallest dimensions possible, and to use copper leads to connect to the indicator or recorder. This, unfortunately, meant that the thermo-couple head at which point the cold junction was situated, was in a position where it might be subjected to wide variations of temperature. To overcome this difficulty, steam heating of the thermo-couple head had been introduced. Another method was that of water-cooling the head of the pyrometer, a practice adopted in one large works in America, but in both these methods troubles arose from leakages in the water or steam pipes. In 1904, W. H. Bristol suggested that the cost of the thermo-couple might be reduced by the employment of a metal and an alloy, the two wires together giving an e.m.f. equal to that of the platinum-platinum-rhodium thermo-couple at a definite temperature, but owing to the high resistance of the alloy wire it was not found possible to extend its length beyond the head of the thermo-couple. It occurred to Mr. Peake, who at that time knew nothing about Bristol's work, that an alloy of copper with a very small proportion of nickel might be made which would give the same e.m.f. against copper as the platinum couple, and yet have a resistance only very slightly greater than that of pure copper. After a considerable amount of experimental work, an alloy of copper with a small proportion of nickel was found which answered these requirements. This had immensely simplified the use of thermo-electric pyrometers, as leads made of this alloy and copper wire could be used in place of the ordinary copper lead to connect from the head of the platinum thermo-couple, enabling the cold junction to be shifted to the galvanometer terminals, where the temperature variations were usually small.

The next error to be faced, that due to changes in the galvanometer itself, might be classed under two heads:—(1) Error due to the cold junction temperature being different from the assumed standard; and (2) error due to variation in the resistance of the millivoltmeter with temperature. Professor Thwing, Mr. C. R. Darling and the Cambridge Scientific Instrument Company had partially overcome these errors by means of various bi-metallic compensation arrangements fitted to the galvanometer. When it was not possible to fit either a bi-metallic compensation on the galvanometer suspension head or to use the scale control box designed by Mr. Peake, the customary method was to immerse the cold junction in ice, copper leads being run from it to the galvanometer. A Dewar or Thermos flask would be found suitable for holding the ice. In laboratories in which ice could not be used, or for clinical records as in hospitals, a small copper constantan thermo-couple was made which could be placed in a water bath maintained at a constant temperature by a gas flame and toluol regulator, or, preferably as he thought, in an electrically-heated chamber. The latter arrangement had been designed and patented by Mr. Horace Darwin, F.R.S.

The scale control box, which had been designed by Mr. Peake, gave a far more open scale and greater accuracy than could be usually obtained with thermo-electric pyrometers. It also contained an extremely ingenious compensating arrangement for preventing the two errors already mentioned due to variations in the temperature of the apparatus itself. It was designed to set up electrically the zero of the recording instrument, so that the scale covered only the actual working temperature.

The next invention described by the lecturer was an automatic triple commutator switch. Where the different records from two or more thermo-couples were not likely to clash, as in the case of an annealing furnace and a flue temperature, there should be no objection to recording them on the same paper. This commutator would give the records of three different thermo-couples on the same chart. Every minute a contact mounted on the rotating shaft of the thread recorder operated a switch which introduced in rotation one or other of the thermo-couples, and the records were distinguished by different arrangements of dots.

The recalescence tracer originally designed by Mr. H. Brearley, of Sheffield, for rapidly attaining recalescence curves of samples of steel, was semi-automatic in action. It had a very open scale, and had been used for samples as small as ½ in. diameter and 1 in. long. Another comparatively recent form of thermo-couple potentiometer for measuring accurately small differences of potential not exceeding 30 millivolts was exhibited. The smallest division on the slide wire scale represented 100th of a millivolt, and by estimation of tenths readings could be obtained to one microvolt without the aid of a vernier. This rapid working was especially useful in determining the freezing point of a metal or in plotting the cooling curve.

The Joly meldometer was next described. It is used for determining the melting point of minute

pieces of rock or valuable specimens. The specimen is mounted in a strip of platinum, the linear expansion of which, estimated by micrometrical adjuncts, gives the temperature at which the specimen, as observed in the microscope, is seen to melt. Temperatures, the lecturer said, could be measured up to 1,400 degrees C., and it was possible to detect difference of 1 degree at 1,000 C.

Referring to improvements in the Féry spiral radiation pyrometer, Mr. Whipple described a modification introduced for determining the temperature in a Hoffmann brick-kiln. A focussing head was fitted to the instrument, so that the manager might set the micrometer himself and leave the workman to take the temperature of the bricks at a definite depth.

The closed-tube Féry pyrometer was designed for satisfactorily determining the temperatures of molten iron and steel. With the ordinary Féry pyrometer, one had to guard against many unknown quantities, such as the large corrections introduced by the difference between the true temperature and the apparent "black body" temperature, the question of oxidisation on the surface of the metal, the formation of slag, and the different radiating properties of different substances. To overcome these difficulties, he had suggested a modification of the instrument in which the concave mirror was permanently fixed in position at the open end of a long tube which was closed at the other end. The mirror was permanently focussed on the inside of this closed end, and projected a heat image of the closed end on to a small thermo-couple just as in the standard Féry pyrometer. The tube was a steel tube fitted with a salamander or fireclay end tube. By using this form of pyrometer "black body" conditions were available, whilst no focussing or other adjustments were required, and a temperature could be determined in about one minute. The temperature readings were independent of the depth of immersion of the tube provided a length equal to at least three times the diameter of the tube were exposed to the temperature. He had on several occasions taken the temperature of molten iron with this pyrometer and had also taken the temperature of molten steel in a small crucible. If the tube was broken a new one could be fixed at once without difficulty at the cost of only a few shillings. Another modification, having an open tube with a specially shaped end, would show almost instantaneously the temperature when placed on any hot body, such as a carriage axle. The lecturer also radiation pyrometer and the platnum-platinum-iridium thermo-couple were used with the same millivoltmeter, and the latter was calibrated with two scales, (1) 800 degrees to 1,700 degrees C. for use with the Féry pyroscope, and (2) 0 to 1,000 degrees C. for use with a thermo-couple. One thus obtained the usefulness and convenience of two distinct pyrometers, whilst the weight and cost were kept down.

Describing a bi-meter CO_2 recorder, Mr. Whipple said that at the Cambridge Electric Supply Company's power station, the introduction of one of these had saved £300 a year in the coal bill. CO_2 recorders were now generally admitted to be of great service in all works employing steam plant, because by indicating the efficiency with which the firing was being done and by showing up promptly any leaks of air into the flues they tended to reduce unnecessary air consumption. Mr. Whipple also exhibited the Méker burner, an improvement on the ordinary Bunsen burner. Whilst the latter burnt a mixture of three parts of air to one of gas, complete combustion required approximately 6 to 1. The Méker burner was designed so as to give the correct proportion of 6 to 1, thoroughly mixed. The deep nickel grid at the mouth of the burner prevented "flashing back," owing to the large cooling surface its perforations presented, whilst molten metal falling on the grid immediately solidified and could readily be removed.

In conclusion, Mr. Whipple said he trusted that he had been able to show that although pyrometry was one of the youngest of the applied sciences it was a living and energetic one, helping manufacturers over some of the difficulties which met them in their daily work.

Discussion.

Mr. Vaughan Hughes, Mr. Morris, Mr. Collier and others having put a number of questions to the lecturer,

Professor Turner, as President of the Birmingham Metallurgical Society, proposed a vote of thanks to Mr. Whipple. He said that a few years ago they had no pyrometers; now they had a multitude, and it was quite evident, from the interest shown in Mr. Whipple's two lectures, that many of those present were already familiar with the use of these instruments. The invention of Mr. Peake for shortening the leads of the thermo-couple was very important. Recently, he had had to pay 250s. an ounce for platinum wire, rather more than three times the value of pure gold, and since, for some purposes, the leads must be at least a yard in length, their renewal was a serious matter. He was glad to hear of the different modifications of the Féry pyrometer, because interesting and useful as that instrument had been in its original form, there was no doubt that the temperature records were sometimes considerably below the mark. It looked as if one could now get at all events a close approximation, if not the absolute truth. He was glad to know that the iron and steel people were now interested in carbon dioxide records, which had been used with great advantage in connection with power plants and tests for boilers, but which he did not remember to have been used in connection with iron and steel work. Few people recognised the enormous influence of the proportion of carbon dioxide in the air on the temperature of the furnace. They saw furnaces in which the issuing gases contained only 2½ per cent. of carbon dioxide, whereas it was possible to get something like five times that proportion. This meant an enormously less dilution of their heat by excess of air passing through the furnace. With regard to the Méker burner he did not think the figures given by the lecturer showed the ordinary Bunsen burner to be as bad as it really was in the centre. In illustration of this statement, Professor Turner showed that it was possible to hold the head of a lucifer match in the centre of the Bunsen flame without its igniting, whilst a piece of paper placed across the flame was scorched in a ring pattern.

Mr. F. J. Cook, on behalf of the Birmingham Branch of the British Foundrymen's Association, seconded the vote of thanks, and said that pyrometry was now making great strides in its practical applications, though he was sorry to say that, as in many other cases, the poor foundry was one of the last to receive the benefit. There were, however, foundrymen most anxiously looking forward to some means of controlling the heat in the cupola by means of pyrometry. No doubt there were many difficulties due chiefly to the vastly changing loads and the way in which the load came down in the cupola. This made it extremely difficult to get accurate observations of the temperature. It was quite easy to get the temperature of the metal on the tapping out of the furnace, and that was very useful; but what the foundryman particularly wanted to know was the temperature in his cupola, and he might then devise

means to alter it if necessary. When the metal came out, if the temperature was not what was required they could only put it aside, but if some method could be devised for determining the heat in the cupola, they would find some means of regulating it and so get vastly better results than were obtained at the present time.

Mr. W. H. Carder (Secretary of the Staffordshire Iron and Steel Institute) supported the motion, which was carried by acclamation.

Mr. Whipple, having acknowledged the vote of thanks, replied to the questions. With regard to the life of the Whipple-Féry Pyrometer extension tube, he said that a great deal depended upon the preliminary heating. If it were heated up fairly slowly in a muffle to, say, 1,400 degrees C., it could be plunged into molten iron. It was proposed in the future to anneal these tubes before sending them out. The tube had not yet been tried with copper alloys. That was one of the things they were hoping to make it useful for. Undoubtedly, where there was a great deal of dust the mirror got very badly tarnished. If heat rays were absorbed by the dust, the couple would not be heated as it should be, and a very low reading would be obtained, but ordinary tarnishing did not matter, because the long heat waves were unaffected by the reflection. In fact, a piece of ordinary tinplate would reflect 90 per cent. of the total radiation it received. With regard to the question of the heat around the instrument itself affecting the action of the pyrometer, it might safely be stated that in most cases this might be neglected. There was no difficulty with a Hoffman kiln, the draught was always downwards so that the instrument remained cool. But in many annealing furnaces they did not get this, and difficulties had been experienced slightly. The question of the best thermometer for a glass furnace was a very difficult one, but the Féry pyrometer had been used in several instances. He knew of two cases in which it was being used for pot temperatures; but if they wished to do experimental work, in which it was extremely important to know the exact temperature, they must be prepared to sacrifice some platinum and place the thermo-couples actually in the beds. He made that statement upon the authority of Dr. Rosenhain. With regard to Mr. Cook's suggestion, Mr. Whipple said that he knew of no way of taking the temperature in a cupola. He had very often wondered how it was to be done—and he was still wondering. (Laughter and applause).

The Sheffield Testing Works.

In our February issue we made a brief reference to the visit of the members of the Sheffield Branch of the British Foundrymen's Association to the Sheffield Testing Works. By the courtesy of Mr. W. Cleland, the managing director, we are now able to give some particulars of those works.

The Sheffield Testing Works is the modern outcome of a business established by the late Mr. Thomas Nash in 1880, for the mechanical testing of all classes of material, the plant consisting of a 10-ton machine, which although still in the works, is seldom used. It must be remembered that this was at a time when mechanical tests had just began to be talked about, though they had not really received any amount of serious consideration.

Mr. Cleland first became associated with the concern in 1880, from which time developments were very rapid. The works were enlarged in 1898, and their scope was extended by the addition of chemical and microscopical laboratories, in order to make the testing works as complete as possible, and to investigate thoroughly the fractures of material when in use. The testing machines include a 10-ton machine for tensile and traverse tests; a 50-ton machine made by Messrs. Greenwood and Batley for tensile, compression and traverse tests; a 200-tons machine by Messrs. Buckton, for tensile, compression, traverse and torsion tests; a cement testing machine; Izod's impact testing machine; a rotary fatigue (Wohler test) machine; a Brinell hardness-testing machine, and a friction machine for carrying out friction tests of oil and anti-friction alloys. There is also a 12 in. lathe, driven by a separate motor, for tool steel tests, and three Herbert file testing machines, for carrying out the file tests lately adopted by the Admiralty and several large railway companies in their contracts for files. A small gas furnace with pyrometers is used for case-hardening, heat treating and annealing of samples, and a smith's hearth is provided for the forging and treating of tool steel. Besides the machines referred to, there is a full complement of lathes, saws, planers, etc., for the preparation of samples and the carrying out of tests in a careful and practical manner.

The first floor of the Blonk Street Works is given over to the commercial offices and the laboratory. The last-mentioned is of necessity very extensive and particularly well equipped for conducting the infinite variety of tests which the works are daily called upon to carry out. To those accustomed to the laboratories in connection with works, that of Blonk Street comes as a revelation, not alone for its general lay out, but also for the orderly neatness in every department. The benches are laid with white tiles. In addition to the usual laboratory auxiliaries there is a copper boiler for distilling water, and a smaller boiler utilising the waste heat, also to distil water. The whole of the Bunsen burners are fitted with fireclay guards, and there is also a small cupola, consisting of a fireclay-lined cast-iron tripod, which, fired with an ordinary Bunsen burner, is capable of melting a small quantity of copper in 20 minutes. For weighing large quantities there is a balance built to the specification of the works chemist by Messrs. W. & T. Avery, Limited. This balance consists of an ordinary pan scale fitted with a steelyard which shows on its respective sides up to 7 lbs. and 3 kilos. The whole of the testing plant, as also the microscopical department, are conveniently arranged in the basement.

As previously stated, the Herbert machine is used for file testing. This machine has from time to time been somewhat roughly criticised, but, as Mr. Cleland pointed out to our representative, the fault lies not in the machine, but rather in the method of testing. Only under very exceptional circumstances could the ordinary works test comply with the necessary conditions for accuracy. At the Sheffield Testing Works the test steel is analysed and tested for hardness, 1 per cent. carbon being most generally employed. The pressure on the metal is a constant factor of 30 lbs. on the sq. in. A copy of the diagram, hardness number and analysis of steel is sent out with all test results.

It is worthy of note that the whole of the mechanical tests are carried out by a staff who have for the most part been educated in the works. Mr. Cleland emphasised the importance of proper preparation of the test pieces. There should be no sudden change in section of the test piece; that is to say, the shoulder and the body should be connected by a fairly long sweep, and all circumferential toolmarks should be removed. This avoidance of sharp corners and removal of tool marks are points in design and finish which are very important if the best results are to be obtained.

Another point to which Mr. Cleland called attention is that of extension, pointing out that the extension per cent. of a test piece on a short length is not the same as that on a long length. This is explained in the following manner. If we mark off a long test piece in 1 in. lengths, as in Fig. 1, and then after fracture measure the extension of each of these lengths and plot a curve it will have the above shape. Suppose that the fracture takes place midway between two of the inch points, then it will be evident that if the material draws down considerably at the fracture, as mild material generally does, the extension per cent. on that 1 in. length will be considerable. The extensions on the 1 in. lengths away from the drawing down are practically uniform, so that the further apart the gauge points are taken the more nearly will the extensions per cent. equal each other. This is graphically illustrated in the following test results:—

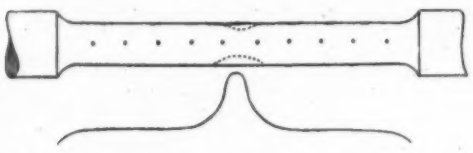


FIG. 1.—DIAGRAM ILLUSTRATING EXTENSION OF TEST PIECE.

adopted both in this country and on the Continent. It consists of indenting the material under test with a pressure of 3,000 kilos applied to a ball 10 mm. dia., then measuring the diameter of this impression and calculating the area of indentation: the load in kilos divided by this area gives what is known as Brinell's hardness number. If the hardness number of a sample in the normal condition be taken and multiplied by 0.2197 the result will be approximately equal to the tensile of that material in tons per sq. in. The method adopted to test tool steel is by taking a $\frac{5}{16}$ in. depth of cut with $\frac{1}{32}$ in. traverse. Tachometers are fitted and the test is checked by stop watches.

There are, of course, a number of machines laid off for adaption to meet particular and specific conditions; such a machine at the time of our representative's visit was testing a white metal bearing and reproducing the action of a motor 'bus on that bearing.

Tests on 2-in. Round Steel for Longitudinal Stays.

Original dimensions.		Distance between gauge points in inches.	Elongation in inches.	Elastic stress.		Ratio of elastic to maximum stress.	Maximum stress.		Elongation per cent.	Reduction of area per cent.	Remarks.
Size in inches.	Area sq. in.			On section. Tons.	Tons per sq. in.	Per cent.	On section. Tons.	Tons per sq. in.			
1.995	3.126	2	1.20	43.15	13.80	62.4	69.15	22.12	60.0	52.1	Silky fibrous.
		4	1.82						45.5		
		8	2.82						35.3		
		12	3.56						29.7		
		16	4.28						26.8		
20.20	3.205	2	1.26	44.70	13.95	62.9	70.98	22.17	63.0	56.0	Silky fibrous.
		4	1.84						46.0		
		8	2.02						32.8		
		12	3.32						27.7		
		16	3.96						24.8		

The method adopted for holding wire ropes for testing purposes is that which is now generally adopted in working practice. It consists of binding the ropes near the end with soft iron wire, then running soft metal into a conical socket round the opened out ends. In order that the wires may not be disturbed during this process, the rope is held in a vice placed over a pit, so that the soft metal is cast round the wires in the same manner as they will be when stressed in the testing machine.

The ordinary testing machine is so well known that it calls for no special description. Readers generally will, however, not be so familiar with the Brinell hardness test, though it is one which is now largely

Anecdotes of the Steam Engine.

Most of our readers have, no doubt, heard of the book entitled "A Descriptive History of the Steam Engine," which was written by Robert Stuart, and published in 1824. This book is now very scarce, but Mr. R. K. Morcom, of Messrs. Belliss & Morcom, Limited, has made a study of the collection of different copies of this volume. It is interesting to note that in one of the volumes which he acquired the following cutting was found, taken from the daily press of September, 1871:—"ROBERT MEIKLEHAM.—We have to record the death of Mr. Robert Meikleham, in the eighty-fifth year of his age, at Kingston, on the 1st instant. The name will probably be unknown to the majority of our readers, but Mr. Meikleham was a noted author in his time, although nearly all his works were issued under a *nom de plume*. In 1824, as 'Robert Stuart,' he published 'A Descriptive History of the Steam Engine,' which was very celebrated in its day, and was highly spoken of by Sir David Brewster, Professor Wallace and others. It went through several editions, and was translated into French and German. Five years later, under the same name, he published his 'Anecdotes of the Steam Engine.' . . . For many years of his life Mr. Meikleham had been engaged in collecting material for a dictionary of architecture and engineering, and a considerable portion was in the press at the time of his death. Another interesting work of his is 'A Practical Treatise on the Construction of Steam Engines,' with numerous engravings." The above clears up any doubts as to the authorship of the works in question.

Britain and the Continent.

Foundry Practice Contrasted.

At a meeting of members of the Sheffield and District Branch of the British Foundrymen's Association, on Tuesday, March 14, Mr. J. Shaw, of Dudley, read a Paper on "A Comparison of British and Continental Foundry Practice." The Paper was illustrated by 60 lantern slides, showing several British and Continental foundries, many of the slides being prepared from photographs taken by Mr. Shaw. Mr. Percy Longmuir, B.Met., President of the Sheffield Branch, was in the chair.

Mr. Shaw's lecture dealt with his observations during a visit last fall to a number of Continental foundries. It was a mistake, he said, for Englishmen to think their practice the best in all particulars, and there was a danger that they did not turn their minds to the plants of their fellow craftsmen to so great an extent as they should. He did not under-rate his own country. Better work, if so good, was produced nowhere; but that the average Continental shop was better laid out and equipped was generally granted. Even in Sheffield there were few firms who could not better the arrangement of their plant if starting now with a clean sheet, unhampered with old buildings, etc. The plant might be modern, but the buildings were so little adapted to the work that they often had to carry their stuff about instead of being able to work on it continuously. It was in this respect their competitors across the Channel held a great advantage. Starting later, their equipment was more modern, and what was of perhaps more importance, realising the rapid growth of trade, room for extensions was planned so that the sequence of operations might still be uninterrupted.

The lecturer first described the works of Messrs. Bollinckx's, near Brussels, who turn out about 150 Corliss engines a year, besides a large number of pumps. The three cupolas, he mentioned, are fitted with receivers—a fairly general Continental practice. It was claimed, and with a good show of reason, that they took less sulphur from the coke and needed less coke on the bed, because the tuyeres might be lower, and that the mixture was more likely to be uniform, because the receiver would hold one or more charges before tapping out. He cited a case illustrating the latter point. A firm he was with some time ago took a fair order for brake blocks. When part way through a chill on the face was asked for. This caused a special charge on the cupola at the finish to keep clear of the machined work. The first day the metal was carried away in 2 cwt. shanks as soon as melted. Next morning, to his surprise, some of the blocks were white all through and others practically grey throughout. By having a ladle capable of holding the whole charge this difficulty was overcome, the melting point of one part of the charge being evidently lower than that of the other. There was a difficulty with shank work with a receiver. Having such a weight of metal behind, they were liable to a misbott. This was overcome at Bollinckx's by using a large ladle from which the smaller ones were filled.

Describing one of Messrs. Sultzer Bros.' cupolas, he said much attention was given to the analysis of the waste gases. The blast pressure and tuyere space best suited for the cupola and the work was arrived at after experimenting for some time with varying pressures and loads. Samples of the gases were taken several times during each heat. In this way they arrived at as near ideal conditions as practical work would allow, viz., comparative cool products of combustion, tolerably free from carbonic oxide. He confessed from the data given by several members on cupola work the only effect of two or more rows of tuyeres was to increase the depth of the melting zone and raise the bed charge, with a loss of fuel. But were they quite sure there were no advantages to be gained if thorough experiments were conducted? Theoretically, they were bound to admit the principle as right.

One special feature in the sand mixing plant at Bollinckx's was a novel screening machine. It consisted of a small bogie on wheels. On this a framework containing a large circular wire brush held in a horizontal position was built. Above this was a hopper with a stiff leather band round the bottom that just touched the bristles. The brush was revolved at about 1,000 revolutions per minute, driven direct by a small motor attached to the frame. The old sand was watered and cut through, then fed into the hopper. They would be surprised how quickly and effectively the sand could be screened from one end of the shop to the other. At Messrs. Bollinckx's elaborate daily tests were taken. A fully qualified chemist with assistants analysed all raw materials as well as tested finished work. No casting of note was made without a full record being kept.

The lecturer dealt, by the aid of a number of slides, with the various methods of testing, and in passing, he called attention to the question of the size of test bars. Some of the authorities failed to grasp the fact that metal suitable for castings $\frac{5}{16}$ in. thick was, to put it mildly, hardly the composition they would choose for others 2 in. thick. Yet within the last few months he had been asked to make castings with those variations, to comply with their so-called standard test, viz., a 2 in. by 1 in. bar tested at 3 ft. centres and give 29 cwts. with 0.3 deflection.

Mr. Shaw described his visit to the large pipe works at Liége. The construction of the pits, he said, differed from English practice. The outer walls of the pit proper formed a large rectangle. Across the narrow way, partitions of steel joists sub-divided the large pit into a series of narrow ones. In each of these narrow divisions six to ten boxes were fixed to the joists. The pit for the smaller pipes was entirely covered over, having the boxes projecting about 18 in. The bottom of the pit was perforated and the sand, when the boxes were knocked out, dropped through into a chute leading to a conveyor that carried the sand to the mixing room. As all pipes were cast socket up, this did away with most of the bottom men.

A visit was also paid to Messrs. Cockerills at Seraing, and then Mr. Shaw proceeded to Düsseldorf in Germany. He was particularly impressed with the number of labour-saving appliances found everywhere. The telpherage systems at some of the works visited were most complete, the iron, coke, etc., being loaded in the stockyard and taken automatically straight to the cupolas. He saw a German bed-plate being made without a pattern, but confessed he could see no saving. Both the inside and outside were formed with cores, and while the system certainly allowed them to lengthen or widen the bed if they still retained the same cross-section of the legs, that small advantage could be gained with the pattern in loose pieces.

Referring to automatic sand mixing, he said that in Belgium the Ronceray machines were giving good

results, but it was in Germany that the automatic machines were to be seen to the best advantage. He gave an interesting description of the process.

Discussion.

The PRESIDENT, in opening the discussion on the Paper, said Mr. Shaw had gone over a lot of interesting ground and had shown among other things the advanced condition of this industry on the Continent. A specially good point he made was that all those Continental works started with a clean sheet. If in Britain they could do the same and start with green fields many of their establishments would be better off than they were to-day. It was not always a question of plant, but rather one of adapting the existing buildings so that the best results could be served. (Hear, hear). Although the illustrations they had seen and many of the examples which had been given that evening showed the high state of efficiency attained on the Continent he did not think they need be dismayed. (Hear, hear.) Notwithstanding the American and Continental advances, no country in the world could to-day produce a ton of pig-iron as cheaply as Great Britain. (Hear, hear.) In certain classes of castings, too, Britain held the market, and so also in certain classes of steel. It was their duty to recognise that their Continental neighbours were developing. But how were they developing? Mr. Shaw had shown them that it was due to system. These Continental firms had not the reserve of skilled labour that English firms had, but to other industries as well as the foundry industry they had given systematic study. They in England could very profitably copy them in this respect and the greater their application of common sense to the methods of their industry, the better the results obtained. (Hear, hear.) It was not wise to rely on tradition or on conservative methods. As he had listened to Mr. Shaw he had been more or less unconsciously contrasting French and and Italian methods with those of Germany and Belgium. If any of them had seen the French and Italians they would be impressed with the excitement which prevailed while their moulds were being cast. On the other hand the Englishman was cool and collected and was most likely smoking his pipe while the work proceeded. The Italians and French would also have six or seven men where England would have one or two. But the moment they get into Germany and Belgium, and especially Germany, they got the comparative calm they saw in England. These two countries had taken their industries up earnestly and were no doubt developing rapidly.

MR. HOLT, of Messrs. Greenwood & Batley, Leeds, did not think the foreigner came up to the Britisher in moulding skill, though they must all admire the mechanical methods which their Continental friends had adopted

MR. W. H. HATFIELD, of Messrs. Crowley & Company, Sheffield, said his little experience abroad had taught him that despite all the development which had taken place, there was no need for them to unnecessarily trouble and worry. Mr. Shaw had spoken of laying out a plant on new ground. It was not long since there were green fields on the Brightside side of Sheffield. These are now covered with plants which were among the best in the world, and produced the best results in the particular industries in which they were engaged. (Hear, hear.) One thing he should like to mention—the elaborate certificates of tests. After looking at the pipes produced it seemed rather a waste of time to go to all this trouble setting out the physical and chemical tests, and then to cast the pipes the wrong way up. (Laughter.) If they would spend a little more time over the actual casting the results would be more satisfactory. Sand mixing was an important matter in the moulding industry, but the machine which Mr. Shaw had shown them was complicated and costly. They were bound to consider the expense in such a matter.

MR. SMITH, of Staveley, said it was a long time since he saw such a primitive pipe shop as that shown on the screen, and as the last speaker said, the pipes were made the wrong way up. He was also astonished to learn that at those works there were no collapsible bars. They could not do without them in this country. They could not make pipes pay under such conditions, nor could they make sound castings. Nor did he think such pipes would pass the test in this country. The test for pipes was becoming more severe than ever. (Hear, hear.)

MR. SHAW, in replying to the discussion, said he had not hinted even that there were not good shops in England—as good shops as anywhere and turning out as good work as anywhere. But were they prepared to say there was that continuity of work which they found on the Continent? He would not depreciate the British work or British workshops; his point was that they were hardly up to the Continental places in equipment. He did not speak of the work done or of the men. England had a long way the best men, but their Continental friends had faced the question of men by their mechanical appliances. Referring to the sand plant, he knew it was costly, but the sand was always right and it was always alike. He wanted Englishmen to know it was not Brummagem goods that were being made on the Continent to-day; they were goods of quality. In regard to the pipe foundry 36 in. pipes were being made there for Glasgow. All he wanted the foundrymen of England to realise was that by equipment our Continental neighbours were making great headway in the industry of the foundrymen.

Mr. Shaw was heartily thanked on the proposition of the CHAIRMAN, seconded by MR. HATFIELD.

Correspondence.

Cementite in Cast Iron.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—In going through the discussion on the Paper read by Mr. Hailstone before the Manchester Branch of the British Foundrymen's Association, published in your last issue, I regret to find you have made a mistake with reference to my views on the question of cementite in cast iron or steel. You state, in reference to cementite as a definite chemical compound, that I only considered the other constituents held in solution in cast iron or steel as not being definite chemical compounds. My suggestion is that cementite also is not a definite chemical compound including all the other constituents which have been demonstrated in the past by the microscopic investigators. I clearly point out and prove in my West of Scotland paper, which I read in December last, that carbon is absorbed in molten iron in direct proportion to the increase of temperature from a given point, and is expelled from iron in the same inverse ratio until the point approaching solidification, when under certain conditions practically the whole of the carbon is thrown out of solution in the graphitic form.

I shall be pleased if you will kindly make this more clear in your next issue.

Yours etc.,

W. J. Foster,

Darlaston Blast Furnaces, Darlaston.

Useful Foundry Ideas.*

Drying Casting Ladles.

For this purpose an open fire may be used, such fire being laid within a surrounding brick wall (Fig. 1), and fed with compressed air introduced through a nozzle at the bottom of the fire. The ladle is simply turned upside down on the brick ring, so that the flame of the fire comes into direct contact with the inside, an outlet for the hot gases being afforded by

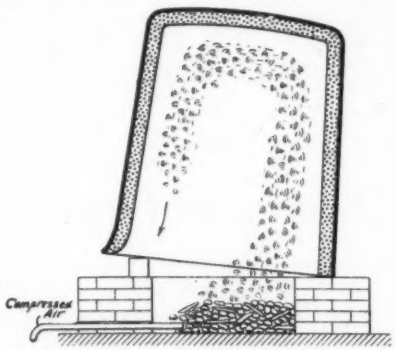


FIG. 1.—DRYING A CASTING LADLE.

placing a loose brick under the edge of the ladle at one point. The room in which the fire is situated is served by a small hand crane. Fig. 2 shows a drying oven, made by F. Feldhoff Sohn, Barmen, and possessing points of undeniable superiority over the open fire method, being more economical as regards waste of heat, and drying the ladles more uniformly, whilst preventing the inconvenience caused by the gases escaping into the workroom.

Pouring from Crucibles.

A very useful novelty consists in replacing the ordinary casting ladles by crucibles, the steel being

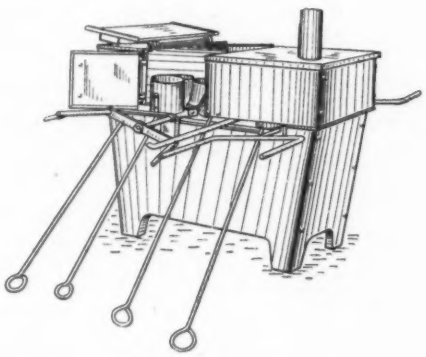


FIG. 2.—DRYING OVEN.

poured from the furnace into a crane ladle, and transferred thence, according to requirements, into the smelting crucibles that have been previously made red hot. These crucibles, which are carried in the usual way, are about 16 to 20 in. in height by 7 in. in diameter across the belly, the dimensions being important in order to ensure favourable conditions of cooling.

Mould and Core Drying.

In one large foundry the waste heat from the glowing ingot moulds is utilised for drying the cores intended for the next series of moulds cast. With this object the cores are placed in between the finished moulds in the pit, and the latter is covered over, the cover being utilised for supporting the moulds for casting the next set, these latter being dried by

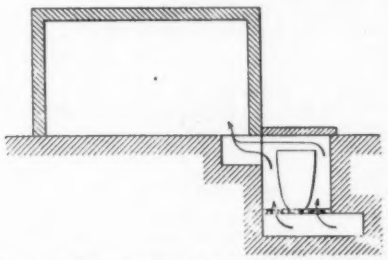


FIG. 3.—EMPLOYING WASTE HEAT FOR DRYING.

the ascending heat. In another works the pits are fitted with removable vaulted covers, thereby converting them into drying chambers, fire buckets being arranged in the corners and communication established with a chimney stack by means of a flue. At many works the waste heat of the drying chambers is drawn into service for drying the sand, the hot gases on their way to the smoke stack being passed through a series of flues in the roof of the drying chamber, the sand being spread over the top of

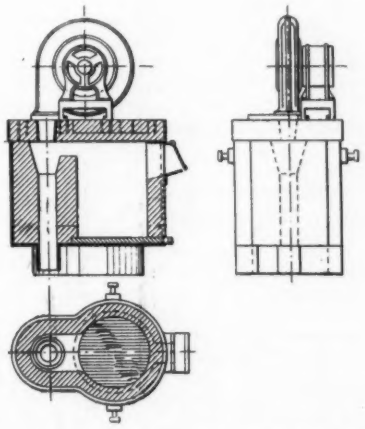


FIG. 4.—PORTABLE DRYING OVEN FOR MOULDS.

same. This method, however, is advantageous only when the sand-treating plant is close to the drying chambers. At one foundry the waste heat of the melting furnace is employed for heating the drying chamber, as sketched in Fig. 3.

* Extract translated from "Stahl und Eisen."

Portable Drying Oven for Moulds.

One form of oven, which is made by A. Gutmann, Ottensen (Hamburg), is about 5 ft. high and 20 in. in diameter; it can easily be transported by hand and connected up with a compressed air supply, the degree of pressure being almost immaterial. It consists in the main of a cylindrical firebrick shaft, with an annular air shaft between the latter and the outer casing. A flat hearth is provided at the bottom of the shaft. The compressed air draws a current of air into the casing, where it divides, one portion traversing the annular space between the casing and the shaft, whilst the remainder ascends through the central shaft itself. The mixing of the hot and cold gases takes place in a chamber underneath the shaft. By regulating the admission of cold air the moulds can be prevented from burning. The admission of the current of air through the fire from above ensures the combustion of the carbon monoxide and smoke, instead of allowing the latter to become deposited on the moulds.

Another form, made by T. Mongen, Mülheim-on-Rhine, and shown in section and plan in Fig. 4, is more advantageous, because both currents of air are forced by a fan direct into the flared feed pipe. The blast required for keeping up the fire is drawn through the latter by an electric fan mounted on the top of the oven. The mixing of the fresh air and hot gases is regulated by carefully dimensioned nozzle orifices, and is arranged in such a manner that the temperature of the hot mixture does not exceed 250 degrees Centigrade, thus preventing the moulds from burning. The height of the coke chamber ensures a fair heating capacity. There is no trouble from smoke when recharging, no compressed air is necessary, and low-grade coke can be used as fuel.

The Moulding of Large Condenser Pipes.

By W. Needham.

Methods of moulding pipes vary considerably according to the design and dimensions. The general method of providing a pattern for a pipe of the design and dimensions shown in Fig. 1 would be very costly. The method of using a loam block might be suggested, but

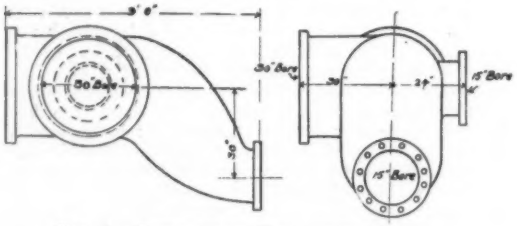


FIG. 1.—POSITION OF PIPE WHEN MOULDED.

this would also be very costly, as it would require several days' labour before it was ready for use.

Both the above methods would tend to reduce the profit on the job. The method the writer is about to

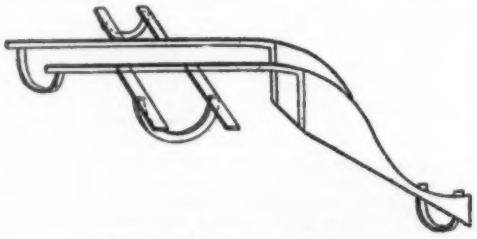


FIG. 2.—DIAGRAM OF FRAME.

describe is a very cheap one, and was carried out with strickles and a frame, therefore requiring very little pattern-making. The time allowed for delivery of the pipes in question was very short, and this method was selected out of several suggested as being the cheapest and also the quickest way of producing the castings, and it proved to be very successful.

The first part of the mould to be made is the bed, which is made large enough to admit the wooden frame as per Fig 2. Strickle *c*, Fig. 3, is then used, which gets the exact centres required. The frame is again placed on to the bed, and wooden plugs are driven into the

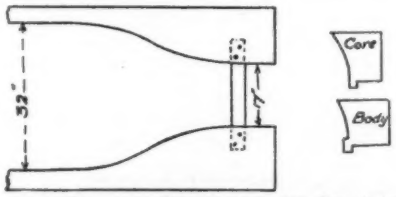


FIG. 2A.—PLAN OF BOX-FRAME FOR SWAN-NECK WITH TWO STRICKLES WHICH WORK ON EDGES OF FRAME.

bed, to screw the straight part of frame to, the swan neck part of frame, Fig. 2, being secured with the box frame.

The sand is then dug out to admit the flanges, and the frame is placed back on to the mould, screwed to plugs, the flanges levelled and squared, and rammed

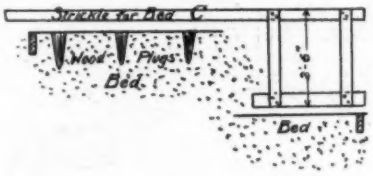


FIG. 3.—SECTION OF BED.

sufficient to hold them in position while being tried over a second time, to make sure that all the flanges are square with each other.

Strickle No. 1, Fig. 4, is the next to be used, and is worked through the mould and kept clear of the sand about an inch, to allow for facing sand. The facing sand is then applied and rammed sufficient to consoli-

date the bottom of the mould, followed by ordinary shop sand. Strickles Nos. 2 and 5, Figs. 5 and 6, are then used and the mould made to suit same, which completes the dummy for the core, which is coated with parting sand or paper.

The strickles for the 30-inch diameter branch are the same as used for the pipe body, and similar strickles are used for the 15-inch diameter branch, in exactly the

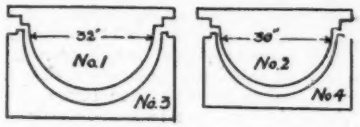


FIG. 4.—STRICKLES FOR 30-INCH PART OF PIPE.

same manner. The dummy having been formed, about ¾ in. of facing sand is placed in the core box, and the core iron is then put into the mould and lifters put in where necessary. Ramming is then continued with ordinary sand to about the centre of mould, which

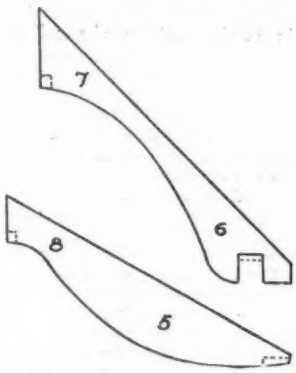


FIG. 5.—STRICKLES 5 AND 6.

NOTE.—These strickles also used as 7 and 8. No 5 worked inside of flange, and 6 on outside. Strickles altered by removing pieces from end, as shown by dotted lines.)

is well vented and covered with a good layer of coke and hay to keep the air passage clear. Ramming is continued to suit strickles Nos. 3 and 6, Figs. 4 and 5, which are worked on their respective parts of the

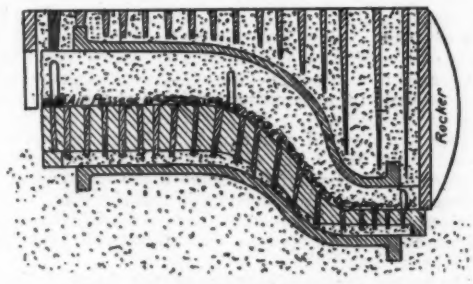


FIG. 6.—SECTION OF CLOSED MOULD.

mould, this completing the dummy for the top part to be rammed on.

The screws are then taken out and the frame removed from the mould, and the top half of the flanges are placed on to the corresponding half flanges, squared and staked to prevent moving while being rammed on. The top part is then placed on the mould, facing sand applied, grids and lifters put in where necessary, and top part rammed up and well vented. This having been completed, the top part is lifted from the mould, turned over, and finished ready for putting back on to the mould.

The frame is then placed back on to the mould, and strickles Nos. 4 and 7, Figs. 4 and 5, are next used, which sweeps off the sand and gives the required thickness of the pipe. To ensure the thickness of parts which were difficult to strickle, large-headed nails are driven into the mould and core to the depth of thickness required, and the sand on these parts is cut off to the heads of the nails.

This finishes the strickling of the core, which is lifted out of the mould, finished and skin dried. Strickles Nos. 1 and 8, also the branch strickles, are then used, which completes the strickling of the mould or pipe. The flanges are then drawn out, the flange cores placed in, and the mould finished ready for the core, which is placed in position, and the top part having been finished in the meantime, this is placed on the mould ready for casting.

There were half a dozen pipes made in this manner, all of difficult design and large dimensions, including two 30-in. diameter to 15-in. diameter elbow swan-neck pipes, and they only require a few hours' pattern-making on each occasion to alter the frame of the first pipe.

Carbon Determination in Iron and Steel.

A modification of the usual combustion method for the determination of the total carbon in iron or steel is proposed in a recent issue of a French technical contemporary. The weighed sample is melted with five times its weight of a mixture consisting of three parts antimony and one part tin. At the melting point of this mixture, about 800 deg. C., the solubility of the carbon in the metal is so much reduced that most of it passes into a more readily oxidizable condition. The metallic mixture is then ignited in a current of oxygen in a combustion tube, and the resulting carbon dioxide is absorbed in caustic soda in the usual manner. With nickel and tungsten steels, the method is more accurate than the Sarnström method, and it is especially applicable to those materials for which the ferric chloride method alone has heretofore been successful.

Tests for Vanadium.

The U.S. Geological Survey, reporting on effective tests for vanadium, state that the mineral may be digested with nitric acid. If hydrogen peroxide be added to the resulting liquid, a brown colour will appear if vanadium is present. Some vanadium minerals are also attacked by hydrochloric acid and by sulphuric acid. To the solution resulting from the use of either acid, hydrogen peroxide may be added, and a brown solution will show the presence of vanadium, as when nitric acid is used. If either hydrochloric or sulphuric acid is used, metallic zinc may be added after hydrogen peroxide, and a bright blue colour will be given by the reduction of vanadium compounds. The same effect can be obtained in a nitric-acid solution by adding sulphuric acid, evaporating to white fumes, diluting, and adding metallic zinc. If preferred, hydrochdoric acid instead of sulphuric acid may be added to the nitric-acid solution, but in that case evaporation must be carried almost to dryness at least twice to get rid of the nitric acid. The liquid may then be diluted and more acid added, followed by zinc as described.

Theory and the Foundryman.

Address before Lancashire Foundrymen.

At the monthly meeting of the Lancashire Branch of the British Foundrymen's Association, held on Saturday, March 4, Mr. R. W. Kenyon, who presided, announced that the membership of the Association was increasing rapidly, and welcomed the new members of the Lancashire Branch to the meetings. A Paper on "Theory and the Foundryman" was read by Mr. H. Sherburn (Warrington), an abstract of the Paper being as follows:—

The foundryman is, above all things else, intensely practical. The conditions under which his working life begins, develops, and continues compel him to be so. Practical work passably done is the only kind by which he will profit. What wonder then if in the past he has given little or no thought to theory or talk about work, seeing that so many of his fellows have gone through life and have done good work apparently without it.

The practical foundryman, with little or no technical training, has proved that experience (combined with judgment and that sixth sense which often makes him discard unsound principles and reject unsuitable materials) can overcome the innumerable difficulties realised, yet not understood, which are ever before him. There is no doubt, however, that a theoretical knowledge of the principles underlying his work, as well as of the materials used, would lessen his difficulties in so far that the cause of such troubles would be better understood. For when the root of the trouble is located the remedy is much nearer to hand.

Theoretical Considerations.

The theoretical aspect of the making of moulds is perhaps confined to two or three considerations, viz.:—

The design of the pattern to obtain uniform thickness and few sharp angles, in order to prevent, as far as possible, internal strains and stresses consequent upon different rates of solidification and forms of crystallisation.

The disposing of runners and risers to obtain an even rate of cooling.

An elasticity of mould and core to ensure that unnecessary strains and stresses will not be set up in the casting during contraction in cooling.

The area of runners in order to obtain clean castings.

It may be worth while considering briefly the process of solidification in an iron casting. When the mould is filled crystallisation commences immediately. The walls of the casting in contact with the mould are first solidified, owing to the rapid absorption of heat from the molten metal by the mould. The overall size of the casting is, therefore, determined practically as soon as the pouring operation is completed. The formation of crystals, therefore, begins from the outer surface of the casting and continues towards the centre, in contact with the sand walls of the mould. The crystals continue to build upon this towards the centre of the mass, shrinkage having been going on all the time, and the solidified outer shell refusing to follow this internal contraction, the result is that the centre of the casting is porous and spongy.

In the case of heavy castings the difficulty is overcome at times by the use of feeders, but there are instances where it is not convenient to use this form of remedy, and in others the use of feeders would be detrimental. In the case of light castings there is a drawing of the metal in the vicinity of the heavy portion, with a consequent loss of thickness in these places. It is necessary, therefore, to have a minimum of inequality of thickness and to increase the thickness of the casting in the places likely to be drawn away. While it is possible to considerably reduce the evil by the use of an iron mixture having a minimum of shrinkage, the ideal will not be realised until it is possible for the solidification to commence and continue equally throughout the entire casting, or at least more so than we are now obtaining. If this were obtained the problem of porous and spongy castings would be solved.

Examples of Drawing, etc.

Other points of interest in the solidification of cast iron are the enormous strains and stresses set up in a casting owing to the resistance of the outer walls to the contraction of the inner part during the process of cooling. In heavy castings it is not so easy to observe this action as in the case of light castings varying from $\frac{1}{8}$ to $\frac{1}{4}$ in. in thickness. In the latter case there are times when the utmost difficulty is experienced in obtaining castings which will not crack with the slightest shock. It might be said that the difficulty is due to bad design, but it is often necessary to produce castings which from the foundry point of view are of bad construction.

The cause of springing or cracking in light castings is usually found to be uneven rates of cooling, often accelerated by the use of unsuitable runners. In the case of extremely thin castings it is often necessary to knock off the runners immediately after casting in order to prevent springing, while in other cases the remedy for springing is found by altering the position of the runners. The judicious use of flat gates is also beneficial, although greater care is necessary with their use; otherwise dirty castings will result. Flat gates are much more in favour in Continental foundries than in this country and lighter castings are more common.

The following examples show another condition in moulds through which strains are put on castings. A flat plate measuring about 36 in. by 24 in. with a thickness of about $\frac{1}{16}$ of an inch, the centre of which is taken out at one end, is shown in Fig. 1. When this casting came out it was seen that while the shrinkage had been normal in the closed end, the size at the open end had not contracted at all. In the second case, the casting consisted of a rectangular frame measuring about 28 in. by 16 in., of a similar thickness to the former one, but having the centre taken away, leaving a frame of about 3 in. in breadth and of either flat or moulded section. This casting came out with the sides bulged out as indicated in Fig. 2, instead of being straight as required.

The reason for the distortion in the shape of these castings is found in the bank of sand which in the first case forms the gap in the end of the casting, thus preventing the normal contraction of the metal at that end, while in the latter case the body of sand in the centre had a similar effect. Had it been possible to remove this sand immediately after casting, the contraction would have been uniform throughout and the

correct shape would have been maintained. In this case the simplest way out of the difficulty is to bend the pattern in the reverse direction to allow for the distortion thus caused. These examples illustrate very clearly another source of strain in castings as a result of the resistance of the mould to the contraction of the metal or cooling, and often the failure of castings to resist shock is due to this cause rather than to their general weakness.

The above problem leads up to the more difficult question of camber, which is perhaps the most troublesome matter connected with the production of light castings of any size. Castings of simple shape do not present much difficulty in this respect, but the majority require some attention. There are two methods by which castings of fairly large surface may be obtained in a straight condition:—(1) By casting from a pattern which is bent in the opposite direction to which the castings will come; (2) by baring the casting in certain parts soon after being run, when made from a straight pattern.

The former is the most reliable method, but where only one or two castings are required, and the time and expense of making a correct pattern is not warranted, the latter method may be successfully operated with a little experience. The chief disadvantage of the latter system is due to the strains which are liable

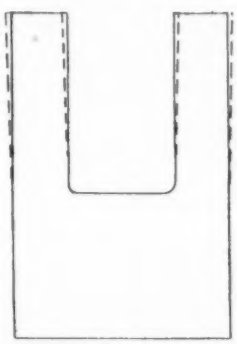


FIG. 1.

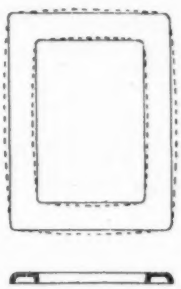


FIG. 2.

to be put on castings through the partial baring at a comparatively high temperature.

Runners.

While the position of runners is a matter of great concern to foundrymen, the area of the same presents an aspect of the problem which perhaps has not received the consideration it deserves. Providing the sand has been strong enough to withstand the wash of the metal the foundryman has often been satisfied to omit consideration of the runner area. This matter, however, deserves more attention, and in light castings practice often makes all the difference between good castings and scrap.

A runner from the theoretical point of view should be so constructed that it is full of metal during the whole period of pouring, the reason for this being that the runner which is kept full of metal has less friction upon its sand walls owing to a thin film of iron protecting them, and consequently there is less liability for sand to become detached and washed into the mould.

Numerous instances have come before my notice where dirty castings have been due to defects in this respect. If for example, we assume that we have a runner about one foot long, it follows that in the event of its being of the same diameter throughout, the lower part of it will deliver metal at a greater rate than is possible in the upper part, owing to the increased pressure in the lower region caused by the head of metal. Consequently a runner of such description is never full of metal until the pouring of the casting is completed. Downgates and runners should therefore be constructed so that their area gradually decreases from the head towards the mould and the only check should be at the point of entrance to the mould. By this means a quick filling of the entire runner is attained, a most important point if clean castings are desired.

[The speaker at this point proceeded to outline some of the possibilities of analysis in the foundry, and its limitation.]

In conclusion, I have endeavoured to show briefly, the benefit that a practical man can receive from a study of the theoretical aspects of his work. It is often difficult to see where practice ends and theory begins, for in some cases the dividing line is almost imaginary. But theory without practice in the foundry is useless, while it should also be remembered that practice alone does not complete the equipment of the modern foundryman.

Discussion.

MR. SIMKISS said he believed that more foundry troubles were due to bad design and the subsequent formation of the pattern than to any other cause. Difficulties in moulding should receive greater consideration in planning out designs. With reference to sponginess in castings—perhaps the most difficult problem of the moulder—he suggested that the use of hot moulds might tend to remove this difficulty.

MR. HAWLEY said the case in which test bars cast from the same ladle and under identical conditions were found to give quite different results furnished one of the many problems for investigation. Regarding the castings which Mr. Sherburn said were distorted during cooling, he suggested the digging out of the sand in the centre of the mould prior to closing of the box.

Another member remarked that he had been much interested in the Paper, but with regard to analysis he should like more light on the matter. On one hand we were sometimes told that if we stick to analysis we were all right, and on the other hand we were informed that it was unreliable and useless. It would be advantageous if some general line of agreement could be arrived at.

MR. ANDREW also spoke on the variation in results in test bars cast from the same metal under similar conditions, and thought that greater facilities should be provided in our big centres of education for practical invesigation, under working conditions, bearing upon this subject. It was remarkable that a certain class of casting could be made successfully in a shop for some time, but on taking up the same thing again under similar conditions, nothing but wasters could be produced.

MR. CHIPCHASE had known cases where, in order to be up-to-date, the control of the foundry had been removed from a practical foundryman and placed under the supervision of a laboratory. The results, however, had not been satisfactory, and while it was undoubtedly an advantage to understand analysis, the experience of the practical man was indispensable, especially those "born foundrymen," as many of the elder ones were.

MR. HARRISON thought Mr. Sherburn had been rather rough on the theorist. There was plenty of scope for research in foundry practice, and the work of the theoretical man was necessary.

MR. PENLINGTON said the Branch had been used to Papers both practical and theoretical, but the present

one seemed to take a course between the two. The points raised provided sufficient material for a session's discussion. He quite agreed with the views advanced with reference to the area of runners, which coincided with what he had advocated for some time.

Mr. Sherburn, in reply, agreed with Mr. Simkiss that sufficient attention was not paid to the design of castings to avoid points of weakness and strains, but reminded him that where castings of certain specific form were essential other methods of overcoming the weakness must be thought out. With reference to Mr. Hawley's suggestion for the open frame, that was scarcely practicable where large quantities were in question. Although some difference in opinion existed as to the value of analysis, he thought a tolerable agreement was in view. The cause of variation in test bars which from the same ladle gave widely different results could be generally found by careful observation of apparently trivial points. He agreed that the facilities for practical foundry work of any value were wanting in most technical institutions claiming to teach such subjects, but thought that if foundry workers would show by their large attendance that better equipment was necessary, it would be provided. No practice was, however, equal to actual foundry conditions. Replying to Mr. Harrison, he did not wish to depreciate the value of the services of the chemist in the foundry, but intended to show how useless was the mere theorist, apart altogether from practice in any department of industry.

A hearty vote of thanks to Mr. Sherburn for his interesting Paper brought the meeting to a close.

Queries and Replies.

Iron Mixture to Give 3,000 lb. Transverse Test.

Can you give me a mixture for iron castings that will stand a test of 3,000 lbs. per square inch transverse, the test bars to be 1 inch square and 12 inches long?

"Inquirer."

Answer.—The stipulated test of 3,000 lbs. per sq. in. transverse bar of 1 in. by 1 in. by 12 in. span (British Admiralty) should, with an approved mixture, not be difficult to obtain. The bar that is in general use in British engineering shops and foundry laboratories is the standard bar 2 in. by 1 in. by 36 in. The Admiralty test for the transverse strength of cast iron is that a bar 1 in. by 1 in. section should stand a load of 2,000 lbs. applied in the middle, when resting on supports 12 in. apart. The approximate equivalent of this test calculated on a standard bar 2 in. by 1 in. by 36 in. would be about 2,666 lbs. The appendix to a recent lecture on "Improved Cast Iron," delivered by a member of the technical department of the Frodair Iron and Steel Company, Limited, and which appeared in the February issue of the Foundry Trade Journal (page 87), showed some very good records of tensile and transverse strengths. Reference to these tests in conjunction with an article upon the relation between transverse test records on Admiralty and standard engineer's bar, found on pages 77-80 of "Handbook for Ironfounders," issued by the above Company, and recently reviewed in these columns, will furnish considerable help to the founder, to whom such tests are of paramount importance. It may be said that a mixture of 40 per cent. Frodair, 30 per cent. Norrfield, 20 per cent. C.B. Lydka, and 10 per cent. scrap has given on three specimen standard bars a mean breaking load of 4,143 lbs., or calculated approximately to the equivalent on an Admiralty bar, of 3,107 lbs. A mixture required to give a 3,000-lb. test on an Admiralty bar, *i.e.*, approximately 4,000 on a standard bar, should include some cold-blast or charcoal iron, and the brands of the foregoing mixture are, we believe, reliable. They can be obtained from the Frodair Iron and Steel Company, Limited, together with any information of a supplementary character relating to tests demonstrated by certain mixtures.—Ed. F.T.J.

Cupola Practice.

I often see in articles on cupola practice that the melting zone is given as 12 inches, 14 inches and 16 inches above the tuyeres. Which is the correct height, and what method is there of ascertaining whether the coke bed is the right height? Also, what weight per hour should a 31-inch diameter furnace (inside lining) bring down, and what weight of lime-stone per ton should be used? We use about 2 parts pig and one part scrap iron. We recently had trouble with castings sinking, and the only difference in our procedure, apparently, was that in the mixture one of the brands of pig-iron was replaced by one very low in manganese. Would this account for the trouble? At times we are troubled with dull iron. We have 3 tuyeres with about 3 inches difference in the height of each, one being 18 inches, one 21 inches and the other 24 inches above the sand bottom. Would these be better all one height, and what would be the proper height? The castings made vary from ¼ lb. to 1 ton.

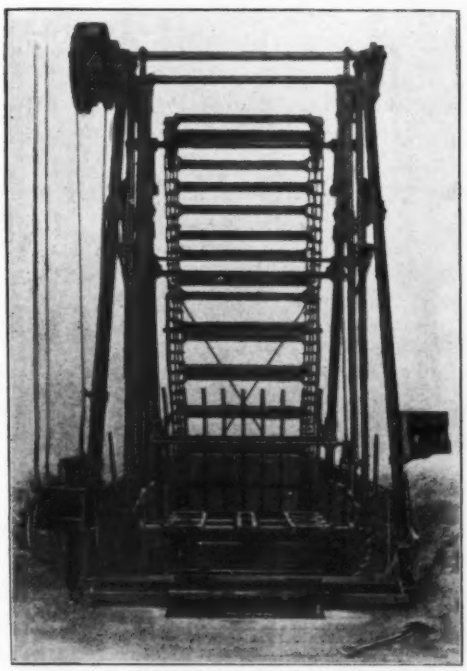
"R.B."

Answer.—The question of the position of the melting zone in a cupola is a much discussed one, and few authorities are found to agree absolutely on the matter; but it may be taken that it commences on the bed of coke, and varies within fairly wide limits, according to the rate of working, the amount of blast being supplied and the stage of the heat. As regards the height of the coke bed, by some writers 18 inches above the top of the tuyeres is considered about correct, but this must be varied according to experience if rapid or economical melting is desired. The average results from cupolas 31 inches diameter (inside lining) are from 3 tons to 3½ tons per hour where melting continuously for three or four hours, and the amount of limestone necessary to be charged per ton of iron will vary (according to the ash content of the coke and the other impurities in the charge) from 36 lbs. to 48 lbs. This question of limestone additions may be the key to the dull melting sometimes experienced, for by correctly fluxing the cupola hotter metal can be got, and with less coke, than in cases where the flux is insufficient. The reduction in the manganese mentioned in the query would most probably account for the sinking, while also the fluidity of the molten metal would be detrimentally affected unless the charge was graded so that other constituents controlled the fluidity in the absence of sufficient manganese. As regards tuyeres, the system mentioned above is not favoured among first-class cupola men, the preference being for tuyeres all on the same level. If it is desired to introduce air at a higher point, a row of upper tuyeres may be installed, but these would not be operated at the commencement of blowing. With the tuyeres of varying height the area into which the blast is introduced is extended irregularly and does not conduce to the bed burning evenly. In the case mentioned the better way would be to raise the position of all the tuyeres to that of the highest, or 24 inches above the sand bottom. Then, if rapid melting is desired, a row of tuyeres about half the area of the lower ones could be placed about 9 inches to 12 inches (not more) above the lower tuyeres. Since small castings are at times included in the output, this arrangement should prove advantageous, as both rows of tuyeres could be utilised when hot, fluid metal is required for the smaller work. —Ed. F.T.J.

Foundry Plant and Equipment.

Buch Gravity Moulding Machine.

The gravity moulding machine shown herewith is based on the fact that after packing or compressing sand into bodies of the proper size and shape such bodies can be uniformly packed into the flask to any degree of firmness desired by dropping them a comparatively short distance. It was found after much experimenting that a drop of 11 ft. was ample for any class of work. Further experiments, however, demonstrated that to practice such a method successfully it was necessary to accomplish the following:—(1) To compress or pack the sand into bodies or strips as long or longer than the width of the flask, but of such thickness that a series of such bodies are required to fill a flask; (2) to provide controllable means for automatically compressing the bodies or strips of sand; (3) to provide a practical mechanism for elevating and for discharging the bodies of sand from a sufficient height to cause them to pack uniformly together



THE BUCH GRAVITY MOULDING MACHINE.

around the patterns in the flask; (4) to provide suitable means for moving the flask back and forth across the line of fall of the bodies of sand to cause them to be discharged into the flask in their proper relation to each other so as to ram up the mould uniformly throughout.

The Buch gravity moulder automatically riddles the sand and compresses it into properly shaped bodies; the flasks are automatically filled with a series of these compressed unitary bodies of sand, and the same operation which automatically fills the flask simultaneously rams up the mould uniformly throughout, regardless of the depth of the flask or the size and shape of the patterns. It strikes off the surplus sand from the top of the filled flask, and it automatically draws the pattern perfectly straight from the mould without the aid of stripping plates and without breaking down the sand on the most intricate or difficult work, except gears, on which the use of stripping plates is advocated.

In operating the machine, the sand having been tempered over-night, is placed in two large heaps, one on each side of the machine. When the machine is started, a roller feeder at the bottom of the hopper feeds the sand in an even stream from the hopper to the elevator, and it is carried by the buckets of the elevator and discharged at the top into the flask below, which is supported on a swinging cradle. While it is being elevated, each bucketful of sand is engaged by a compressor which automatically compresses or packs the sand in the buckets. The pressure exerted by this compressor can be instantly adjusted so as to pack the sand in the buckets to any degree of firmness desired, by which means the moulds can be made hard, soft or medium, as may be required. The flasks are rammed up by a succession of compressed bodies or strips of sand falling beside each other until a layer is formed across the entire area of the flask, after which additional layers are built up in the same manner until the entire mould is formed of some solid mass of sand of the same degree of firmness throughout. These machines are used for making a general line of castings, and it is stated that castings weighing up to 1,500 lbs. each are being moulded on them.

The height of the machine is 14 ft. 10¾ in. above the floor, and it extends 5 ft. 6 in. below the floor. The No. 2 machine has a total width of 9 ft. and weighs 12,000 lbs.; the No. 3 a width of 11 ft. and a weight of 15,000 lbs.; the No. 4, a width of 13 ft. and a weight of 20,000 lbs.

The makers are the A. Buch's Sons Company, Elizabeth Town, Pa., U.S.A.

A New Open-Hearth Furnace Charging Machine.

We illustrate herewith a new open-hearth furnace charging machine recently constructed by Messrs. Thomas Broadbent & Sons, Limited, of Huddersfield, who have taken up the manufacture of this form of appliance. The design embodies all that is most up-to-date in machines of this type. Local difficulties in the shape of limited amount of headroom available impelled the makers to adopt, in the apparatus illustrated, an extremely compact design, and the way in which this feature has been carried out is well worth noting. The machine is constructed of specially selected materials and in such a way that it is highly suitable for rapid service. It embodies seven different motions, and the strains and stresses were taken out so that the machine would be quite equal to the manipulation of three tons of charging metal at the end of the box-arm, although the working load will only be equal to two tons.

The motions are as follows:—Longitudinal travelling, by motor; cross traversing, by motor; bar rocking or tilting, by motor; bar turning, by motor; slewing, by motor; vertical lifting and lowering, by motor; locking of box-arm in end of box, by hand. It will thus be seen that six of the motions are each

operated by a separate motor. A unique feature of the machine is that it embodies both hoisting and rocking or tilting motions.

To meet the requirements of the severe service for which the machine is intended, the wearing areas throughout are of ample design. The structure is rigidly stiffened in all directions with the idea of resisting the constant reversals of stresses, these varying considerably in magnitude, due to the slewing motion being required to operate at different levels of lift, and also to the sudden picking up and dropping of the load. In order to limit as far as possible the range of these stresses, the revolving centre of gravity of the machine is confined within a small radius; and in the machine under notice the effect of the weight of the rocking gear has been utilised to partly balance the load at the end of the box-arm. This effect is further increased by the weight of the cab and its contents, which, in addition, considerably lessen the work of the rocking motion.

Fig. 1 gives a general view of the charging machine and shows the loaded box in its lowest possible position. The small space taken up by the machine above the trolley wheels in order to bring it within the limited amount of headroom, of which mention has already been made, will be evident from this photograph.

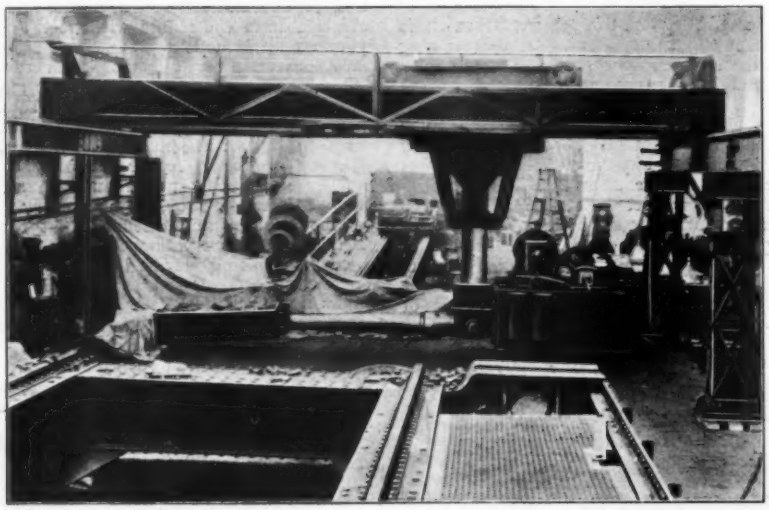


FIG. 1.—OPEN-HEARTH FURNACE CHARGER, SHOWING LOADED BOX IN LOWEST POSITION.

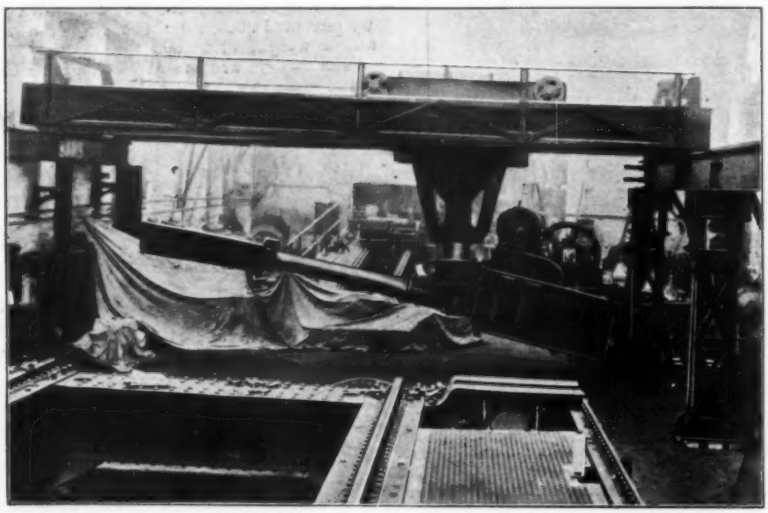


FIG. 2.—OPEN-HEARTH FURNACE CHARGER, SHOWING LOADED BOX RAISED TO HIGHEST POINTS OF ROCKING AND VERTICAL LIFT.

Fig. 2 gives a similar view, but in this the loaded box is raised to the highest points of rocking and vertical lift. In this connection it must be borne in mind

that the box can be lifted very much higher than would be the case if there were only one of these motions in the machine. The charging box in the highest position is raised through a distance equal to something like three-quarters of the distance from the ground to the gantry-rail level.

Tabor Jarring and Roll-Over Moulding Machine.

The machine herewith illustrated is one of the latest designs of the Tabor Manufacturing Company, Philadelphia, Pa., U.S.A. It combines a 6-in. shockless jarring machine and a 30-in. roll-over machine, the pattern-drawing cylinder giving a straight draft of 12 in. In Fig. 1 is shown a flask clamped to the pattern-plate, and resting on the jarring table with the bottom board secured preparatory to rolling over. This is accomplished by admitting compressed air to the roll-over cylinder, whereupon the arms of the hinged frame come in contact with the pattern-plate, lifting the flask clear of the table before it begins to roll over. An eccentric on the trunnion shaft actuates

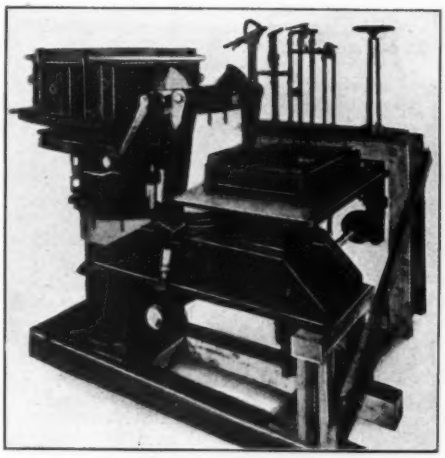


FIG. 1.—TABOR COMBINATION JARRING AND ROLL-OVER MOULDING MACHINE.

locking bolts, which secure the pattern-plate to the hinged frame and hold it firmly when inverted. Finally, the flask is lowered upon the receiving table, which adjusts itself to the inequalities of the bottom board, and the clamps are removed from the pattern-plate permitting the pattern to be drawn. The receiving table is adjusted vertically for different depths of flask by the hand wheel shown in the upper right corner of the illustration. After the pattern is drawn it is rolled back upon the jarring table, as shown in Fig. 2, ready to receive another flask. The flask being filled with sand, the starting valve is depressed and jarring continues automatically until the valve is released. The latch lever at the left of the controlling devices in the illustrations regulates the stroke, which can be varied while the mould is being rammed from 1 to 4 in. A few short strokes at the start liberate the enclosed air in the sand, and with a longer stroke the remainder of the work can be done more effectively and quicker.

The Schultz Electro-Magnetic Separator Drum.

Wherever electrical energy is available, the permanent magnet is now being superseded by the electro-magnet, the defects of the former being low power of attraction and comparatively short working life. This

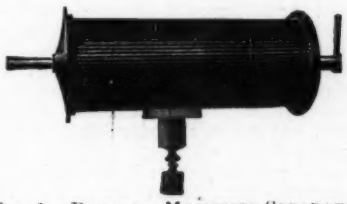


FIG. 1.—DRUM OF MAGNETIC SEPARATOR.

is particularly the case with magnetic separators for the elimination of iron from mixtures in which its presence is undesirable. One of the recent forms of electro-magnetic devices for that purpose is the Schultz separator drum, which is made by the Magnet-Werk,

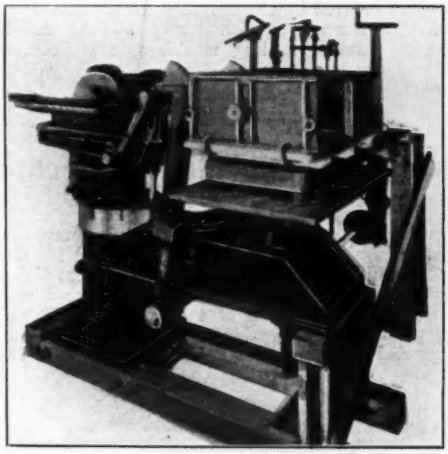


FIG. 2.—TABOR MACHINE WITH FLASK ROLLED OVER AND PATTERN DRAWN AND ROLLED BACK.

G.m.b.H., Eisenach, which is illustrated herewith. Fig. 1 shows an external view of the drum, and Fig. 2

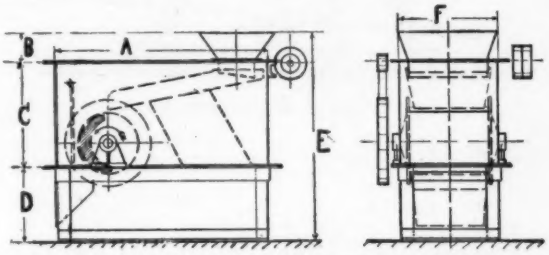


FIG. 2.—CONSTRUCTION OF MAGNETIC SEPARATOR.

a sectional elevation of a separator equipped with this drum.

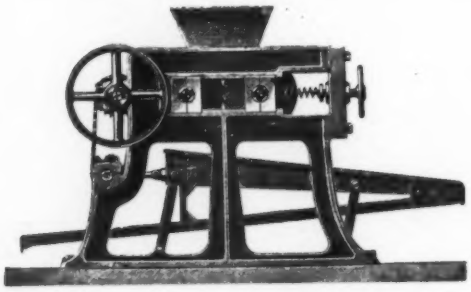
The apparatus consists of a stationary electro-magnet arranged inside a rotary shell or drum so as to set up a magnetic field on one side only of the drum. The material to be freed from iron is fed down a vibrating shute, as shown in Fig. 2, and on reaching the drum, the non-magnetic particles slip down over the surface, and are discharged, whereas the magnetic portions of the material are held against the drum surface by the attractive force of the electro-magnet, until the drum in the course of its rotatory movement has carried them beyond the influence of the magnetic field, which done, they also fall down and are collected in a separate receptacle. Instead of cast iron, the casing is made of iron sections and strong plate, the whole being made airtight. The current is supplied to the electro-magnet through the stationary hollow shaft of the drum, so that no slip rings or contact brushes are required.

The dimensions of a separator for foundries of medium size are: Length 2 ft., height 32 in., breadth 16 in. The magnetic attraction is barely 1-10th h.p., and the excitation, with 110-volt direct current, about 1 ampere. The fast and loose pulley measures 10 in. in diameter and is provided with a belt fork. The speed is 60—80 revs. per minute.

The separator is made by the Magnet-Werke, G.m.b.H., Eisenach, who also apply the same principle to a lathe face plate for holding delicate work that cannot be secured by the ordinary forms of mechanical chuck. The same appliance may also be fitted to grinders, planers, milling machines, saws, etc.

A Crushing and Sifting Machine.

In the accompanying cut is shown a sifting machine and crusher for sand. The apparatus comprises a crusher and a sieve, and is principally used for treating old moulding sand. The sand passes first through the crushing cylinders, which are kept close together by springs acting on one of the cylinders. This disposition allows the breaking of the lumps of sand, but permits the passage of moulding pins and metallic



SIFTING MACHINE WITH CRUSHER.

pieces which may become mixed with the sand These are retained and separated by the sieve placed under the crusher.

The output per hour is 90 cubic feet from the small size of machine, which has a sieve 48 in. by 32 in., and requires approximately 2 h.p.; the larger size of machine, which has a sieve 80 in. by 48 in. and requires approximately 3 h.p., is 160 cubic feet per hour. The makers of the apparatus are Messrs. Bopp & Reuther, of Mannheim-Waldhof, Germany.

The "F.T.J." Bookshelf.

Introduction to the Study of Metallurgy.

By the late Sir W. C. Roberts-Austen, K.C.B., D.C.L., D.Sc., F.R.S., etc. Sixth Edition, revised by F. W. Harbord, A.R.S.M., F.I.C. London: Charles Griffin & Company, Limited.

Since the year 1890, when the author offered the first edition of this work to the public, it has grown steadily in favour as a standard work on metallurgy. In this, the sixth edition, we see the work extended and revised by a well-known authority on the subject, to bring it into line with the recent advances which the science of metallurgy has experienced, the general scheme of the book, however, being preserved. As an example of the revision work, the table of Physical Constants has been revised in accordance with the latest available data, while all matters relating to Alloys have been transferred to a separate chapter. The chapter on Pyrometry has been practically re-written, and a new chapter on "Metallography" replaces the one on "Microstructure" in the last edition. The subject of Fuel, also, is given a chapter to itself, and is illustrated by types of modern coking ovens and gas producers, while the subject of Furnaces for metallurgical practice has been supplemented by sketches of the principal types of electric furnaces. These revisions bring a valuable work up-to-date, without destroying the character of the book or in any way dissociating it from its esteemed author.

Electro-Metallurgy.

By Walter G. McMillan, F.I.C., etc. Revised by W. R. Cooper, M.A., B.Sc., A.I.C. London: Charles Griffin & Company, Limited.

This is the third edition of a treatise embracing the application of electrolysis to the plating, depositing, smelting, and refining of various metals, and to the reproduction of printing surfaces and art work. The author's endeavour has been to systematise and explain, as far as possible, the various electro-metallurgical processes, treating the subject in a technological rather than a technical manner; and it must be admitted that a very clear and interesting treatise has been presented, unencumbered by any superfluity of technical details. In the case of each subject the principles and main details of the operations are briefly and clearly set forth, while instructions are frequently given for the guidance of workers in special operations. In short, a very acceptable combination of theory and practice is presented. Some important revisions of the earlier editions have been effected, owing to the advances recorded by electro-metallurgy during the past few years. For instance, electric smelting and refining, though dealt with but briefly as a whole, requires different consideration from what it received in the earlier editions, when the electric smelting and refining of iron was non-existent An instructive section of about 18 pages, including a number of illustrations, is therefore given on that subject, the principal electric furnaces for iron being described. The greater part of the original matter dealing with the dynamo has been omitted from this edition, as the subject could not be properly treated in the space available, and there are various other text-books dealing thoroughly with it. A considerable portion of the book is devoted to the electro-deposition of various metals, such as copper, silver, gold, nickel and cobalt, iron, platinum, zinc, chromium tin, lead, etc., and also alloys of various metals. General conditions to be observed in electro-plating are outlined in one chapter, while the plating adjuncts and the disposition of the plant is a

further subject treated. A comprehensive chapter also embraces the subject of the electro-metallurgical extraction and refining processes, and several further pages are devoted to the recovery of certain metals from their solutions. It will be seen that for the electro-plater, in particular, the book contains a fund of valuable information, while to other branches of electro-metallurgy it is also very applicable. A useful index completes the work, making reference to any subject easy and convenient.

Mining and Metallurgy Abstracts: Journal of the International Institute of Technical Bibliography.

London: The Institute, 57—57, Chancery Lane, W.C.

These abstracts form one of seven sections of the publication issued by the International Institute of Technical Bibliography. It will be remembered that not many years ago the Royal Society's "Catalogue of Scientific Papers" was handed over to the control of an International Council with regional bureaux; later a similar reorganisation was made in connection with "The Poole of technical periodical literature," viz.—the *repertorium* of the Imperial Patent Office of Berlin. This was transferred to an International Institute of Technical Bibliography, organised on lines similar to those of the International Council. The publication was then transformed into a monthly and extended by the inclusion of book notices. The index is now published in seven sections, and these monthly sectional indexes or "Abstracts" are consolidated at the end of each year in one general alphabet. The classification of the original *repertorium* was on dictionary principles: the titles, headings, and index being in German, English and French, while the entries were compiled in the language of the articles indexed. The new publication follows closely on the old lines, except that the monthly sections have their headings arranged in class order, with a synopsis of the classification prefixed to each number. These abstracts are, therefore, a useful index of the literature on technical subjects which appears from time to time. But we must criticise the method of compiling the entries; for in many cases articles are credited to journals which have simply reprinted the matter from other sources. In some instances this may not affect the value of the index, but when it is remembered that frequently such articles are only reproduced in abstract, this procedure is rather misleading, and might direct attention to a very unsatisfactory summary of what could be obtained elsewhere in full. In view of the fact that the source of such reprinted articles is almost invariably acknowledged, it should be no difficult matter to indicate the source. In other respects the compilation should prove very useful.

Inventions.

Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

3,529.*Tongs for lifting metal tyres, castings, etc., into and out of furnaces. A. J. Sedwell.
3,533.*Electric furnaces. G. Von Schatzl.
3,571. Smelting and refining metals in crucibles by means of electrical heating. H. G. Solomon.
3,640. Gas crucible furnaces. H. J. Yates.
4,171.* Regenerative furnaces. L. Rousseau.
4,204. Foundry moulding-machines. J. R. Moorhouse.
4,272.*Moulding boxes or flasks for foundries. W. Kurze.

Trade Talk.

THE BRITISH ENGINEERING INDUSTRIES COMPANY of Middlesbrough, have relinquished their business.

FLETCHER, RUSSELL AND COMPANY, LIMITED, have opened a branch at 57, Summer Row, Birmingham.

THE directors of Henry Pooley & Son, Limited, recommend that the capital be increased to £165,000 by the creation of £35,000 new ordinary shares of £1 each.

THE LANCASHIRE METAL REFINING COMPANY, LIMITED, have decided to wind up the company voluntarily, with Mr. L. A. Voisey, 5, Bold Street, Warrington, as liquidator.

MESSRS. J. JONES & C. E. HIPKINS, carrying on business as brass founders at 54, Summer Row, Birmingham, under the style of John Jones & Co., have dissolved partnership.

PETRIE & COMPANY, LIMITED, engineers, Whitehall Street, Rochdale, have amalgamated their business with that of John Holroyd & Company, Limited, of Milnrow, near Rochdale.

MESSRS. W. C. PENN and R. P. THORP, carrying on business as engineers and agents, at 25, Victoria Street, Westminster, under the style of W. Cooper Penn & Thorp, have dissolved partnership.

ROBERT HEATH & SONS, LIMITED, of the Biddulph Valley Coal and Iron Works, Stoke-upon-Trent, Staffordshire, have purchased the B.B.H. brand (William Barrows & Sons) of iron and the goodwill.

MESSRS. J. R. KELLY & COMPANY, 25, Bridge End, Leeds Bridge Leeds, have been appointed Yorkshire representatives of Craven Bros., Limited, Manchester, for the sale of Gridley patent automatic lathes.

MR. CECIL BENTHAM, engineer, Hallmark Works, Balby Road, Doncaster, has removed to Wombwell, near Barnsley having merged his business into the Wombwell Foundry and Engineering Company, Limited.

THE STRONG AND PAIGE TOOL COMPANY, LIMITED, of the Stalker Works, Stalker Lees Road, Sheffield, have removed to Drill Square, Langsett Road, Sheffield, and in future the works will be known as the Stalker Drill Works.

THE paper entitled "Commercial Vanadium Steels," which should have been read by Mr. J. Kent-Smith before the members of the Staffordshire Iron and Steel Institute on March 25, has been postponed owing to the severe illness of the author.

UNDER the auspices of the Liverpool Shipping Staffs Association, Mr. J. J. Kermode, M.I.Mech.E., on March 13, delivered an extremely informative lecture on "Oil Fuel, as Applied to Steamship and other Boilers, and to Industrial Process Furnaces."

THE partnership heretofore subsisting between Messrs. W. Taylor, H. Brook and J. France, carrying on business as ironfounders and general engineers, at Millgate Foundry, Paddock, Huddersfield, under the style of Walker Taylor & Company, has been dissolved.

THE NORTH BRITISH RAILWAY COMPANY have placed with W. & T. Avery, Limited, the contract for maintaining in efficient working condition the whole of the weighing apparatus on their system, and also for the supply of new weighbridge and weighing appliances.

MESSRS. J. DEWAR, W. E. TURIFF, and W. S. REID, carrying on business as coppersmiths and brass founders, at the Poplar Copper and Brass Works, Chipka Street, East Ferry Road, Poplar, London, under the style of Geo. Brockley & Company, have dissolved partnership.

THE firm of A. and W. Purvis, engineers, 212, Preston Street, Bridgeton, Glasgow, of which Mr. Adam Purvis and Mr. William Purvis were the sole partners, has been dissolved by the retirement of the former. Mr. William Purvis will carry on the business at the same address.

THE shareholders of Crow, Harvey & Company, Limited, Park Grove Iron Works, 89, Sussex Street, Paisley Road, Glasgow, have decided to wind up the Company voluntarily. Mr. T. McLintock, 149, West George Street, Glasgow, has been appointed liquidator.

THE BRITISH HUMBOLDT ENGINEERING COMPANY, LTD., have recently presented the Bessemer Laboratory of the Royal School of Mines with one of their Wetherill crossbelt magnetic separators. This machine, which is to serve for laboratory purposes only, is built exactly half the size of the ordinary machines.

THE partnership heretofore subsisting between Messrs. G. H. Pennett, H. Mellor, and G. Dunn, carrying on business as engineers at Albion Mills, Batley Carr, under the style of George Dunn & Company has been dissolved. Mr. George Dunn will continue the business under the style of George Dunn & Company.

AT a meeting of the shareholders of John R. Bird, Limited, engineers, Kingston, Glasgow, a resolution was passed to the effect that the company be wound up voluntarily. Mr. H. R. Bird, 71A, West Nile Street, Glasgow, was appointed liquidator. A meeting of the creditors has been called for the 22nd inst.

THE ANDERSTON FOUNDRY COMPANY, LIMITED, has presented a petition to the First Division of the Court of Session at Edinburgh for confirmation of the reduction of the capital from £300,000, divided into 30,000 shares of £10 each, paid up to the extent of £6 per share, to £180,000, divided into 30,000 shares of £6 each, paid up.

OWING to the expansion in their London business George Turton, Platts & Company, Limited, of Sheffield, have arranged with Messrs. Willis, Stewart & Company, 65, New Broad Street, E.C., to act as their representatives for special districts. This arrangement will not affect the company's London office at 110, Cannon Street, E.C.

MR. G. P. WINCOTT, of Savile Street, Sheffield, in order to devote the whole of his time to his rapidly increasing business in furnace building, has given up the general ironfounding branch of his business at the Eagle Foundry, Stevenson Road, and disposed of it to Mr. John L. Moorwood, late of Moorwood, Sons & Company, Limited.

NOTICE is given that, at the expiration of three months, the names of the undermentioned companies will, unless cause is shown to the contrary, be struck off the register, and the companies will be dissolved:—British Stamping and Engineering Company, Limited; London General Brass Foundry Company, Limited; and Turbinal Tubeless Boiler Syndicate, Limited.

THE DOWSON & MASON GAS PLANT COMPANY, LIMITED, of Levenshulme, Manchester, have recently secured an important contract from the directors of the Midland Railway Carriage and Wagon Company, Limited, Birmingham and Shrewsbury, for a complete equipment of forge and plate furnaces, gas producers, chimneys, etc., for their new wagon works at Washwood Heath, Birmingham.

A MEETING of manufacturers and merchants was held in London, on March 15, in connection with the suggested trade mark for goods manufactured in the British Empire. Lord Avebury, who presided, said there was a very strong feeling among manufacturers of this country that the Merchandise Marks Act had been abused. It was agreed that the control of the trade mark should be undertaken by an association known as the British Empire Trade Mark Association, which should also seek the registration of the mark. Mr. C. Freeman Murray was appointed hon. secretary, and the meeting authorised the establishment of a guarantee fund.

NOTICE is given that the names of the undermentioned companies have been struck off the register, and such companies are dissolved:—Accessible Battery and Engineering Company, Limited; Atlas Tube and Fittings Company, Limited; Ferro Alloys Syndicate, Limited; Glovers Water Tube Boiler Company, Limited; Boiler and Engineering Company, Limited; and the Super Refining Metallurgists, Limited; Metal Exchange (Leeds); Anglo-American Aluminium Company, Limited; Chiswick Iron Works and Erecting Company, Limited (registered February 29, 1904); Sir Hiram Maxim Electrical and Engineering Company, Limited.

HENRY WILLIAMS, LIMITED, of Cathcart, Glasgow, have decided to remove their railway appliances works to Darlington, where a site of about two acres having direct access to the main line of the North-Eastern Railway system has been acquired. These works will be located upon a portion of the site of the old Skerne Iron Works, at Darlington, and will be immediately adjoining the Blake Boiler, Wagon and Engineering Company's establishment. Messrs. Williams specialise in the manufacture of railway locking frames, signal posts, and ground fittings, and they expect to open their new works at Darlington by the end of May, affording employment to about 100 workmen.

THE Commercial Law Committee of the London Chamber of Commerce recently appointed a sub-committee to make full enquiry into the widespread complaints which have of late been made in connection with the administration of the Income Tax Acts, particularly as to the inadequacy of the allowance for depreciation, and to the refusal to allow depreciation in respect of buildings, fixtures, fittings and furniture. The Committee, after taking a mass of written and oral evidence, have issued a report, which has been adopted by the Council of the Chamber. The committee made a number of recommendations, of which the following are the principal:—That the production of balance sheets should not be insisted upon by surveyors of taxes, and that taxpayers who object to produce such balance sheets should not be refused the statutory allowance for depreciation or placed under other disadvantages, provided that the ordinary profit and loss account has been certified by a professional accountant; That depreciation should be allowed on: Buildings; purchased terminable annuities; purchased terminable concessions relating to any source of profit arising outside the United Kingdom; and on furniture, fixtures and fittings; That the rates of depreciation on plant and machinery should not be left to the discretion of the surveyors of taxes, but that the General Commissioners should exercise their discretionary powers in fixing such rates.

Legal.

An Iron Moulder's Loan.

In a King's Bench Divisional Court, on March 14, Justices Phillimore and Bankes had before them the case of the Friendly Society of Ironfounders, etc., *v.* Myall, which was an appeal by the plaintiffs from a judgment of Judge Benson, of the Sheffield County Court. Counsel, in opening the appeal, said the matter at issue was connected with the Trades Union Acts. It was an action upon an agreement signed by the defendant that in a certain event he should repay £100, advanced to him on behalf of the society. The correct view was that the agreement, having regard to the circumstances in which it was made, and also having regard to its object and the language of the rules, was an agreement to lend money only to be repaid under certain continuing circumstances. The two questions which had arisen were: (1) Whether the Society was an illegal society, apart from the Trades Union Acts. The County Court judge had found that it was, and counsel submitted that that was erroneous. (2) Whether, if the Society were illegal at common law, this contract was one of those in regard to which the disability from suing in the Courts had been kept up. Continuing, he read the rule under which the advance was made to the defendant. Since the accident defendant had worked in

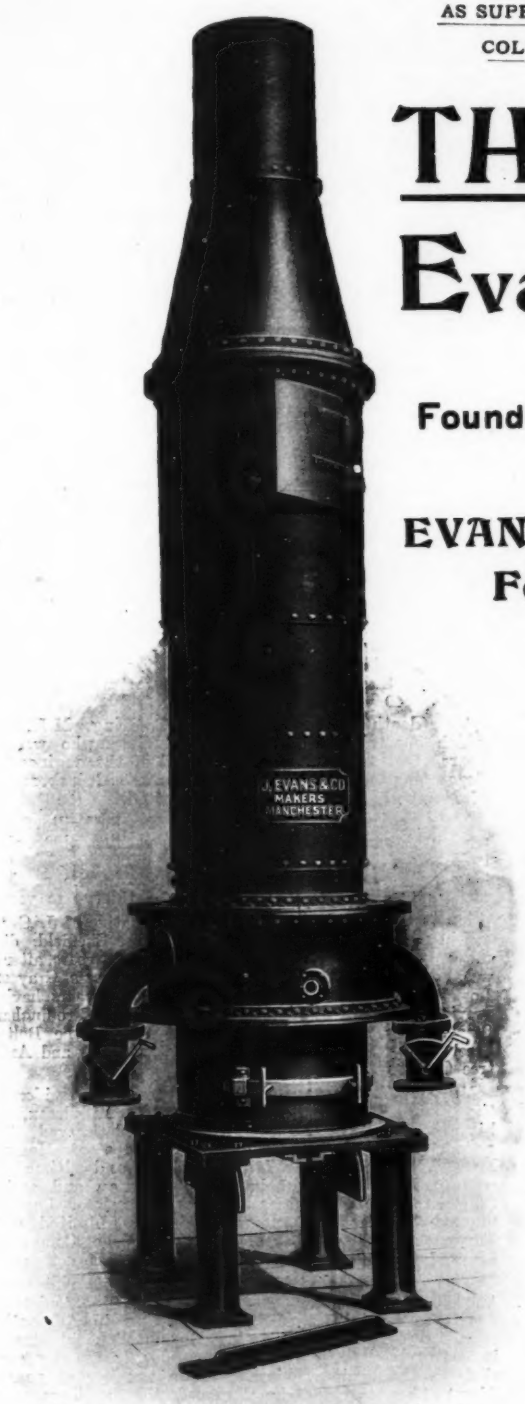
(*Continued on page* 228.)

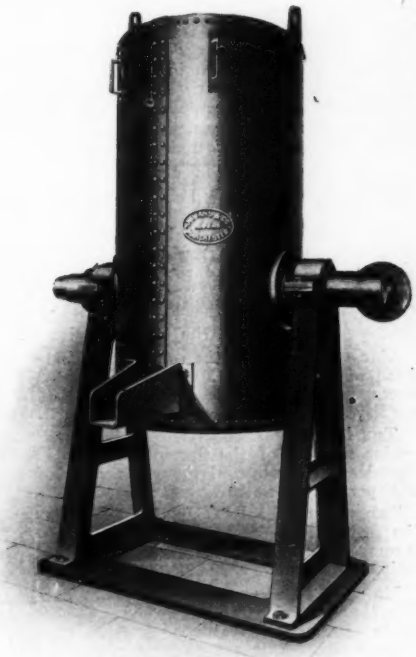
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE,
COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola.
Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.





James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

several places as a core-worker, and the County Court judge found, as a fact, that that employment was part of the ironfounders' trade. The question which the Court would have to determine would be whether any of the rules of the Society amounted to a restraint of trade, and were injurious to the public; and, secondly, whether, if there were such rules, they were severable, or so unseverable in their character, that they necessarily made the whole of the rules of the Society illegal. There were two rules which the County Court judge took exception to. He (the County Court judge) held that the Society could not sue except in accordance with the Trade Union Act, 1871, and, further, that they could not sue for damages for breach of this particular agreement. He, therefore, gave judgment for the defendant. Counsel argued that the Society were suing for a sum they had paid. Defendant had returned to his work, and therefore they were entitled to their money.

The appeal was allowed.

Personal.

Mr. W. B. Dickson, first Vice-President of the United States Steel Corporation, has resigned.

Mr. Cecil R. Darlington has been appointed commercial consultant to the Tata Iron Works, India.

The gross value of the estate of the late Mr. James Henry Burgess, ironfounder, of Tame Bank, Mossley, is £8,277.

Mr. J. W. Summers, M.P., of John Summers & Sons, Limited, has had the Honorary Freedom of Stalybridge conferred upon him.

The late Mr. Edmund Grove, formerly of Cochrane & Company, Limited (Cochrane Grove Branch), left estate valued at £56,993 gross.

Mr. H. D. D. Barman has been elected a director of Stewarts & Lloyds, Ltd., in place of Sir Wm. Arrol, who has resigned his seat on the board.

Mr. T. E. Ingoldby, assistant works manager to Siemens' Brothers Dynamo Works, Limited, of Stafford, has been transferred to London.

The Council of the University of Sheffield have appointed Mr. George Stanfield, B.Eng. (Sheffield), to the post of demonstrator in engineering.

Mr. Robb has ceased to be a partner of the Callendar Iron Company, Falkirk, which is being continued under the same name by the remaining partner.

Mr. W. R. Paige, of the Strong and Paige Tool Company, Limited, Sheffield, has been the recipient of a presentation from the officials and men.

The gross value of the estate of the late Mr. J. Holt, head of the firm of Messrs. Holt and Willetts, engineers, Lion Works, Cradley Heath, is £19,728, with net sonalty £15,172.

The late Mr. J. Morris, of the Foundry, Welshpool, senior member of the firm of J. and M. Morris, ironfounders, left estate of the gross value of £6,342, with net personalty £6,308.

The will of the late Mr. W. L. Wills, a partner in the firm of A. W. Wills and Son, edge-tool manufacturers, Birmingham, has been proved at the present estimated value of £99,671 15s. 10d.

Mr. H. H. Baird, of Baird & Tatlock, Limited, laboratory furnishers, who died on February 4, left estate of the gross value of £31,080 4s. 3d., of which £29,320 19s. 8d. is net personalty.

Mr. J. E. Tully has been elected a director of the Bede Metal and Chemical Company, Limited, in place of the late Sir Walter Scott, Bart. Mr. W. Hall has accepted the seat on the Board vacated by Mr. M. T. Scott.

Mr. T. W. Willis, steel works manager to Thos. Firth & Sons, Limited, Norfolk Works, Sheffield, has been appointed to a similar position with Sanderson, Brothers & Newbould, Limited, and has also become a director of the company.

Mr. H. C. Broadhurst, secretary of J. Stewart and Son, Limited, of the Blackwall Iron Works, London, E., has been appointed secretary to Palmers Shipbuilding and Iron Company, Limited, Jarrow and Hebburn, in succession to Mr. Victor Parker, resigned.

Mr. F. W. Cooper, who has retired from the general managership of the North-Eastern Steel Works, to take up a position at the new works of John Lysaght, Limited, at Scunthorpe, Doncaster, has been the recipient of a presentation from the officials and men.

Mr. James Luther Greenway, of Greenway Manor, Nantmel, Radnorshire, and 3, Princes Gate West, Liverpool, who has been appointed High Sheriff of Radnorshire, is chairman and managing director of Greenway Brothers, Limited, Britain Iron and Steel Works, Bilston, and Liverpool Iron and Steel Works, Widnes, Lancashire.

We learn that a short time ago Sir Hiram Maxim tendered his resignation as a director of the firm of Vickers, Sons & Maxim, Limited, to take place on his seventy-first birthday. Sir Hiram has served continuously as a director, first in the Maxim Gun Company, then the Maxim-Nordenfeldt Guns and Ammunition Company, and, lastly, for many years with Vickers, Sons & Maxim, Limited, making in all twenty-seven years.

Deaths.

The death is announced from the United States of Mr. Ezra Linley, a director of Wm. Jessop & Sons, Limited, of the Brightside Steel Works, Brightside, Sheffield.

The death is announced of Mr. William Charles Derecourt, Sheffield. Mr. Derecourt, who was 67 years of age, had been connected with the firm of Thos. Turton & Sons, Limited, steel manufacturers, Sheffield, for over 40 years.

The death is reported of Mr. T. King, M.I.M.E., which occurred at Penarth. Mr. King, who was 48 years of age, was at one time head of the engineering department of the Britannia Works, Gainsborough, of Marshall, Sons & Company, Limited.

Mr. Robert Cowie, manager of the Bathville Steelworks, Armadale Station, Linlithgowshire, belonging to Dickson & Mann, Limited, died recently. He was fifty-eight years of age, and had been in the employment of Messrs. Dickson & Mann for thirty-five years.

Mr. J. Jones, the well-known representative of J. Grayson, Lowood & Company, Limited, Deepcar, Sheffield; died recently at the comparatively early age of 58 years, after a very brief illness. Mr. Jones had represented Messrs. Grayson, Lowood & Company, for a period of nearly six years, having previously occupied important positions at the Frodingham Steel Works, the Calder Bank Steel Works, the Bolton Steel Works, and the works of the Patent Shaft and Axletree Company, Limited, Wednesbury.

Mr. W. I. Taylor died recently at his residence, the Firs, Bush Hill Park, Enfield, Middlesex, in his sixty-second year. The deceased served his apprenticeship in the engineering shops of Messrs. Losh, Wilson & Bell, Walker-on-Tyne, and ultimately rose to the position of head draughtsman and assistant manager. He subsequently was appointed London manager to Clarke, Chapman & Company, Limited, and London agent of the Darlington Forge Company, Limited, being also a director of the former company.

Mr. G. Anderson, engineer, died at his residence, Annesley, near Arbroath, on March 4. Mr. Anderson was a native of Leysmill, and settling in Arbroath, carried on the ironfounding industry in Dickfield Street, in partnership with Mr. Lundie, and subsequently carried on the business himself for a number of years. About 15 years ago he removed to the Taymouth Engineering Works, Carnoustie, N.B., of which he became proprietor, and under his management the business became quite a large concern under the style of George Anderson and Company (1905), Limited. Mr. Anderson retired from business six or seven years ago.

SOUND

STRONG, CLOSE-GRAINED

CASTINGS

Obtained by using

"TITANIUM THERMIT"

TINS READY FOR USE. **ALL SIZES** from 2 cwt. to 20 tons.

Prices and Particulars from

THERMIT LIMITED,

Telegrams: "FULMEN, LONDON."
Telephone: 3749 Central.

27, Martins Lane,
Cannon Street, E.C.

Works: **210a, Bow Rd., E.**

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years:—

METALS.	End Mar., 1911.	End Mar., 1910.
Iron—Scotch pig warrants ton	*53/4½	*57/7½
—Middlesbro' warrants ... ton	47/7½	51/7½
—W.C. M/nos Bessemer ... ton	66 0	70 0
—Stock, Scotch ... ...tons	1,000	1,000
Copper—Chili bars, GMB ton	£54 7 6	£57 12 6
—Stock, Europe and afloat tons	††82,757	††13,455
Tin—English ingots ... ton	£188 10 0	£149 10 0
—Straits ... ... ton	£187 10 0	£151 10 0
—Stock, London, Holland, U.S.A., and afloat ...tons	†17,556	†22,373
Lead—English pig ... ton	£13 5 0	£13 10 0
Spelter—Ord. Silesian ... ton	£23 10 0	£23 0 0
Quicksilver (75lb)... bottle	£9 5 0	£9 5 0
Antimony—Regulus ... ton	£33 0 0-£35 0 0	£30 10 0

* Settlement price. † February 28. †† March 15.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings:—

	£ s. d.	£ s. d.
Columns (plain)	6 10 0 to	6 15 0
Pipes, 1½ to 2½ in.	4 17 6 to	5 2 6
,, 3 to 4 in.	4 10 0 to	5 0 0
,, 5 to 8 in.	4 7 6 to	4 10 0
,, 10 to 16 in.	4 7 6 to	4 10 0
,, 18 to 24 in.	4 7 6 to	4 10 0
Chairs	3 12 6 to	3 15 0
Floor plates (open sand)	3 0 0 to	3 5 0

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows:—Heavy wrought (mixed), £2 10s. 0d.; light wrought, £1 7s. 6d.; heavy cast, £2 7s. 6d.; all per ton, f.o.b., London. Copper (clean), £50 10s. 0d.; brass (clean), £30 0s. 0d.; lead (usual draft), £12 0s. 0d.; zinc, £18 5s. 0d.; all per ton delivered merchant's yard.

New Companies.

BURNLEY CLOG IRON COMPANY, LIMITED.—Capital £2,000 in £1 shares.

BARTLETT & SON, LIMITED.—Capital £100 in £1 shares to carry on the business of engineers.

VITTY & HOPPER, LIMITED.—Capital £1,500 in £1 shares, to carry on the business of engineers, etc.

HODGSON AND STEAD, LIMITED.—Capital £1,000 in £1 shares, to carry on the business of engineers, etc.

A. G. KENT & COMPANY, LIMITED.—Capital £500 in £1 shares, to carry on the business of engineers, etc.

EASTERN FINANCIAL AND ENGINEERING SYNDICATE, LIMITED.—Capital £12,000 in £1 shares (4,000 preference).

ROLFE MANUFACTURING COMPANY, LIMITED.—Capital £1,000 in £1 shares, to carry on the business of iron and brass founders, etc.

STANLEY MACHINE TOOL COMPANY, LIMITED.—Capital £3,000 in £1 shares. Registered office: Stanley Ironworks, New Bank, Halifax.

HOPE FOUNDRY COMPANY (LONDON), LIMITED.—Capital £10,000 in £1 shares. Registered office: 5, Upper Thames Street, E.C.

BRITISH SAW SHARPENING MACHINES, LIMITED.—Capital £5,000 in £1 shares (2,800 preference). Registered office: 79, Mark Lane, London, E.C.

BURNBANK FOUNDRY COMPANY, LIMITED.—Capital £20,000 in £1 shares, to acquire and carry on the business of the Burnbank Foundry Company, Falkirk.

EFANDEM COMPANY, LIMITED.—Capital £15,000 in £1 shares (10,000 preference), to carry on the business of engineers. Registered office: 71, Temple Row, Birmingham.

FOUNDRY SANDS
OF ALL GRADES.
Owners of noted Birmingham Moulding Sand Quarries—
JOHN WILLIAMS (BIRMINGHAM SAND) LTD.
BIRMINGHAM.

S.M.S
WHAT IS IT?
SWIFT — METALLIC — STOPPING
The British Foundry Cement.
FOR FILLING UP BLOW HOLES IN CASTINGS . . . . . .
IT DRIES IN ONE HOUR, AND IT CAN BE FILED UP IN FROM SIX TO TWELVE HOURS . . . .
SAMPLE FREE — TRIAL TIN 1/-
AGENTS WANTED.
THE SILENT MACHINE COMPANY,
SAVILE STREET, SHEFFIELD.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

Established 1863.

JAS. DURRANS & SONS,

PHŒNIX WORKS, PENISTONE, Near Sheffield.

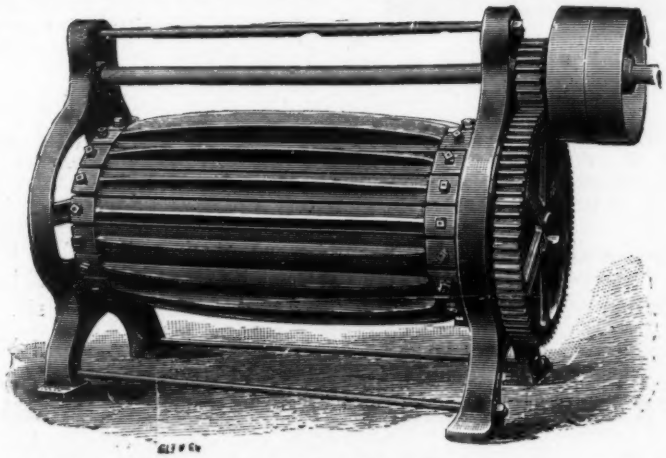
Manufacturers of all

FOUNDRY EQUIPMENTS,

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST.

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

IMPROVED FOUNDRY RATTLER or FETTLING DRUM.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

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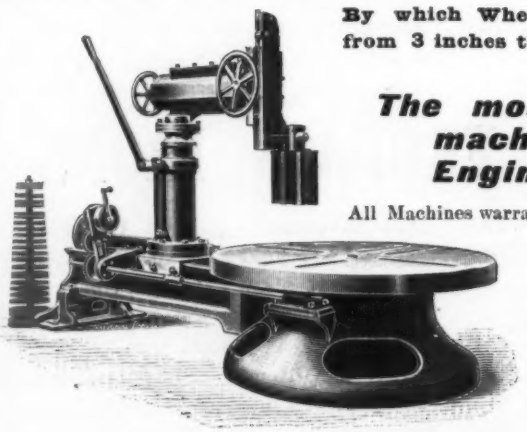

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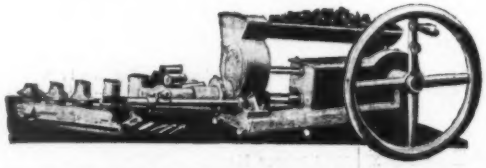

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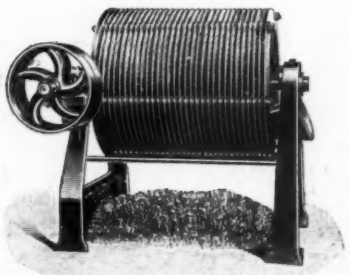

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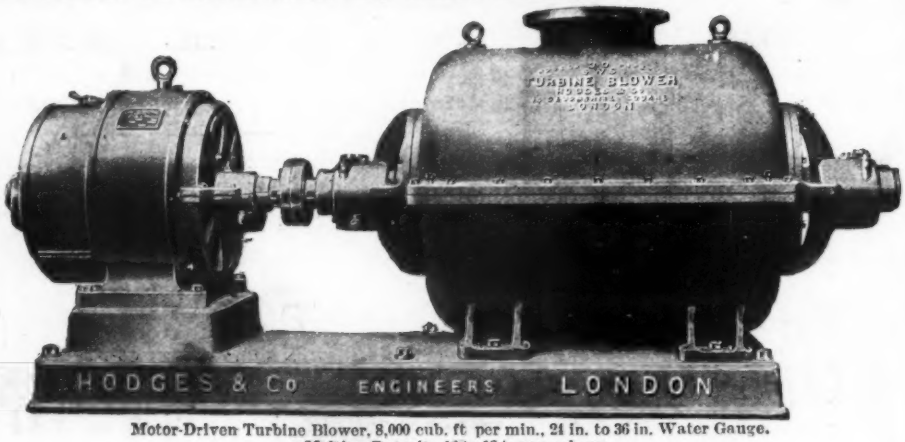

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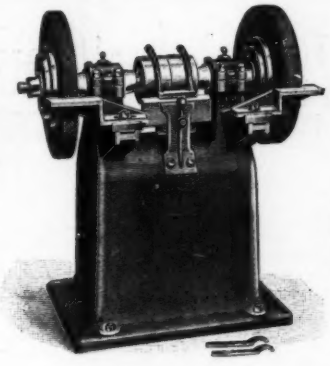

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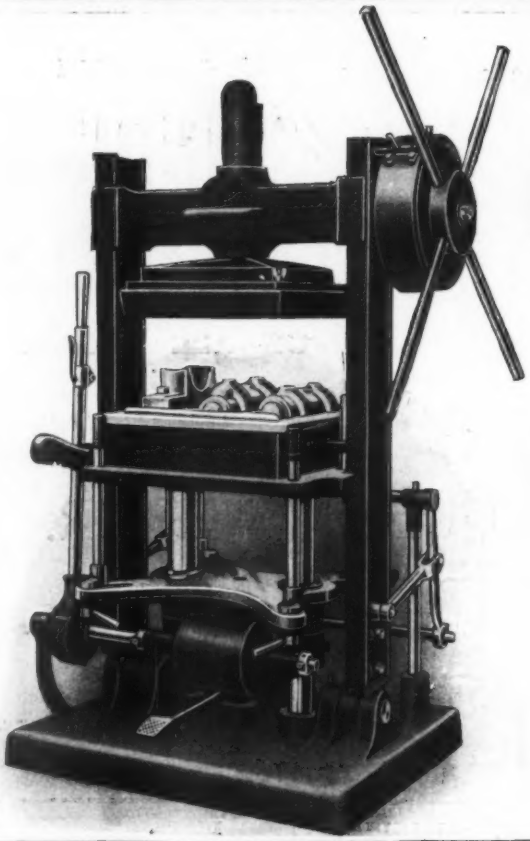

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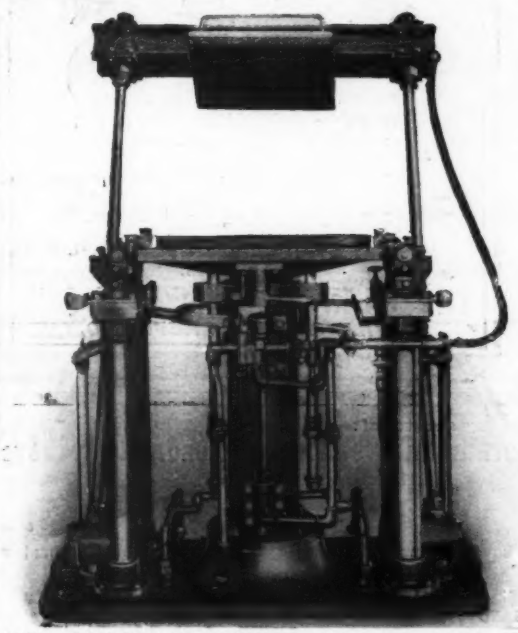

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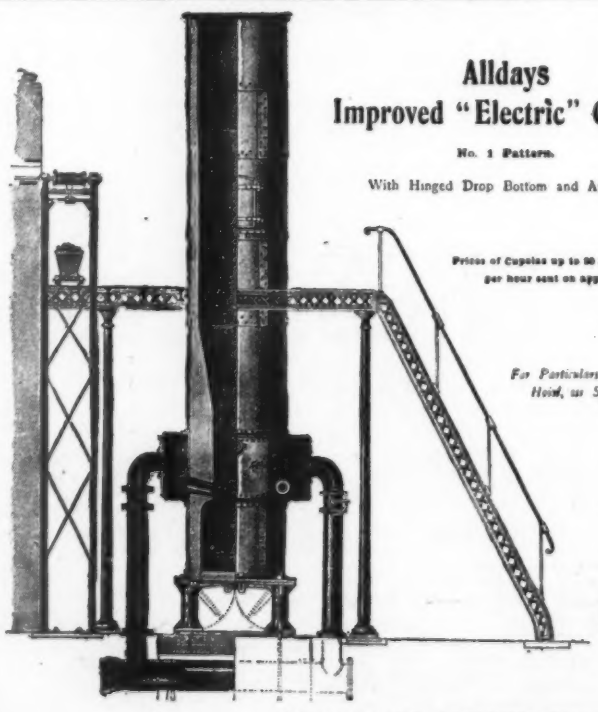

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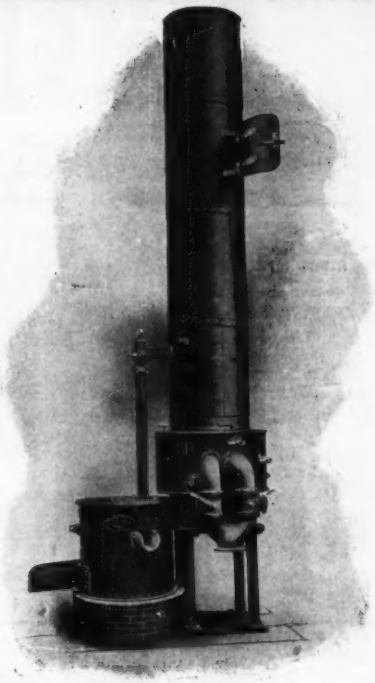

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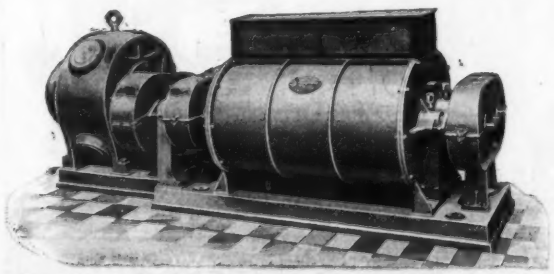

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